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A Theater Missile Defense Integration Study

Active Defense Systems Priorities and Issues
First Quarter, Fiscal Year 1996

Prepared for

Director for Force Structure, Resources and Assessment (J-8)
Joint Chiefs of Staff
8000 Joint Staff, Pentagon
Washington, D.C. 20318-8000

Under Contract No. DASG60-92-C-0173

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Abstract: This GAO report claims that the National Intelligence Estimate for 1995 failed to back up its assertions on the threat of ballistic missiles to the United States.

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CONTENTS

LIST OF FIGURES

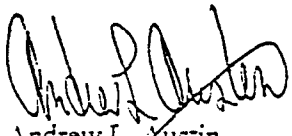
PREFACE

Reporting in May of 1995, the Commission on Roles and Missions recommended that the Office of the Secretary of Defense develop an "integrating function to assist the Secretary in assessing diverse and competing recommendations and providing unified direction for the defense program." The report also emphasized the need for early, top-level assessments of integrated requirements. These recommendations significantly affected theater missile defense acquisition planning in 1995.

As the year drew to a close, the fiscal considerations surrounding this drive for acquisition efficiency became increasingly apparent. The revised *Department of Defense Directive 5000.1: Defense Acquisition* emphasized the concept of *cost as an independent variable* and the need to assess *affordability* at decision points: "Fiscal constraint is a reality that all participants in the defense acquisition process must recognize." This movement toward efficiency and decisiveness was evident as the Joint Requirements Oversight Council (JROC) of the Joint Chiefs of Staff reviewed active defense systems priorities during the first quarter of Fiscal Year 1996. In the days since that review, the pervasiveness of this mood of fiscal conservatism has continued to gain momentum.

In recent remarks presented at the Joint Attack Operations Conference, the Deputy Director for Force Structure, Resources and Assessment (J-8) stressed the need for insight and selectivity in the search for future solutions to operational requirements. He stated the future vitality of the nation's military would demand decisive, timely commitment to the right technologies, systems, or solutions. The recommendations described in this report were developed in that spirit of prudent decisiveness.

This study, like the JROC's review, attempted to adjust the tension between two sometimes opposing forces. While keeping in mind the likely evolution of the theater missile threat, this study describes a strategy meeting the demands of the expansive, dynamic active defense mission, while observing the bounds of fiscal constraint.



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The Advanced Concepts Division study team was comprised of Vernon L. Conner, Director and Task Leader; Alfred F. Barrett, Senior Analyst; Jim Johnston, Senior Military Systems Analyst; John Kirzl, Senior Analyst; Ed Manners, Senior Military Analyst; John A. Paine, Jr., Senior Systems Engineer; Don Steele, Senior Military Systems Analyst; and Paula Swope, Graphics Artist.

We appreciate the cooperation and contributions of the many missile defense experts who supported and advised this study (see Appendix D). Their advice and experience helped define the issues and illuminate the complexities of theater missile defense.

EXECUTIVE SUMMARY

Purpose of the Study

Determining priorities for active defense systems acquisition continued to be a major issue within the Department of Defense during the first quarter of Fiscal Year (FY) 1996. The core systems were well underway, while selected advanced concepts were considered for new starts. Affordability, however, was a concern. Continuing core programs while initiating new programs would eventually require almost $3 billion per year, as depicted in Figure ES-1. To address this concern, the Joint Staff reviewed its acquisition

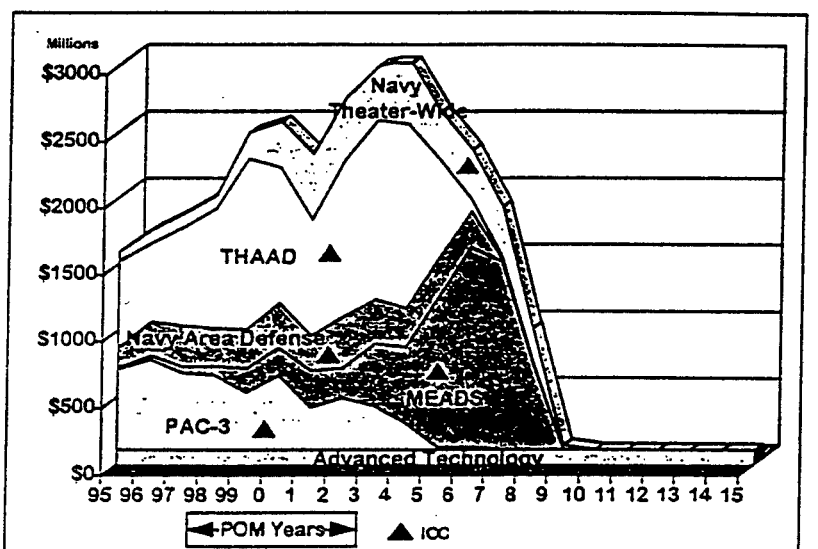


Figure ES-1: Funding Guidance Exceeded

priorities. That review of active defense systems was supported by the team conducting this *Theater Missile Defense Integration Study*. Chartered by the Director for Force Structure, Resources and Assessment (J-8) of the Joint Staff, this study developed a methodology for reviewing requirements and assessing capabilities over time.

Study Methodology and Scope

A comprehensive body of theater missile defense literature was provided to the study team. In addition, numerous missile defense experts granted interviews and provided briefings. The study method was to synthesize available information, approaching it from a Joint Staff perspective. The following steps comprised the analytical process:

- review the anticipated development of the threat over time
- define the required capabilities

- compare capabilities inherent in core programs and advanced concepts with required capabilities
- implement program trade-offs and define integrated decision points: develop a strategy for acquiring systems that paces the threat and complies with funding guidance

This study considered recent analyses of the contributions of attack operations, passive defense, and integrated battle management. Although these operational elements cannot substitute for required active defense capabilities, the synergy of multi-element theater missile defense has the potential to reduce missile inventory required for a protracted war.

Summary of the Findings

Required initial operating capabilities can be fielded on a schedule reasonably pacing the anticipated threat for $2 billion annually. In addition, force structure and procurement levels can be managed through a series of integrated decision points.

The Threat

Short-range ballistic missiles and anti-ship cruise missiles are the predominant theater missile threats today. Between 2000 and 2005, medium-range ballistic missiles, currently under development, are expected to proliferate significantly. Following proliferation, qualitative upgrades in ballistic missiles are anticipated. Improvements will include counter-countermeasures such as penetration aids and fragmenting payloads. Another emerging threat, the land-attack cruise missile will become prominent over the next ten years. Defeating weapons of mass destruction delivered by ballistic and cruise missiles will continue to be a top-priority challenge.

Required Capabilities

Planning guidance and doctrine describe an expansive joint theater missile defense mission. It has political and military dimensions, beginning during crisis development and extending through completion of redeployment. Certainly, counter-proliferation, deterrence, attack operations, passive defense, and integrated battle management make contributions to the mission. Nevertheless, actively *defending* requires the following capabilities:

- ground-based active defense against ballistic and land-attack cruise missiles
- sea-based active defense against ballistic and anti-ship cruise missiles

- a boost-phase intercept capability to counter advanced ballistic missiles (employing counter-countermeasures with the potential to overwhelm terminal defenses)

Acquiring these capabilities will provide joint commanders what they need when they need it. However, systems development must be managed within funding constraints.

Available Materiel Solutions

The core programs, which are within the funding guidance, will provide the following requirements:

- *Patriot Advanced Capability-3 (PAC-3)*:
  - ground-based active defense against short-range ballistic missiles
  - some capability against land-attack cruise missiles

- *Theater High Altitude Area Defense (THAAD)*:
  - ground-based area defense against medium-range ballistic missiles
  - ground-based area defense against many short-range ballistic missiles

- *Navy Area Defense*:
  - sea-based active defense against short-range ballistic missiles
  - active defense against anti-ship cruise missiles

Shortfalls After Fielding the Core Programs

Protecting maneuvering forces against short-range ballistic missiles and land-attack cruise missiles requires a *tactically mobile ground-based active defense*. The *Medium Extended Air Defense System or MEADS*, a partnership among Germany, Italy, France, and the United States, is the leading candidate. However, within the theater missile defense community there are significant discussions on product-improving PAC-3 into a follow-on, designated *Patriot Advanced Capability-4 (PAC-4)* in this study, to meet the requirements of MEADS.

Another shortfall is *sea-based defense against medium-range ballistic missiles*. To meet this requirement, Navy officials advocate initiation of a *Navy Theater Wide* program.

Three *boost-phase intercept* candidates have received support: kinetic energy/airborne intercept, airborne laser, and space-based laser. Boost-phase intercept currently appears to be the best active defense operational concept for defeating the early release of submunitions threat.

The Integrated Decision-Point Strategy

The study's methodology for reviewing requirements and assessing capabilities over time is based on the following guidelines:

- minimize operational risk
- leverage existing systems and technologies
- provide flexibility
- constrain cost (not to exceed $2 billion per year)

These guidelines can be followed by developing a strategy in which decision makers identify points along the system development process to reassess the threat, revalidate operational requirements, and review program and technology statuses. Decision points are designated at those optimal points in program development where sound decisions can be made on: performance-schedule trade-offs, procurement adjustments, and, if appropriate, program initiation/termination. Figure ES-2 provides an example of a MEADS decision point.

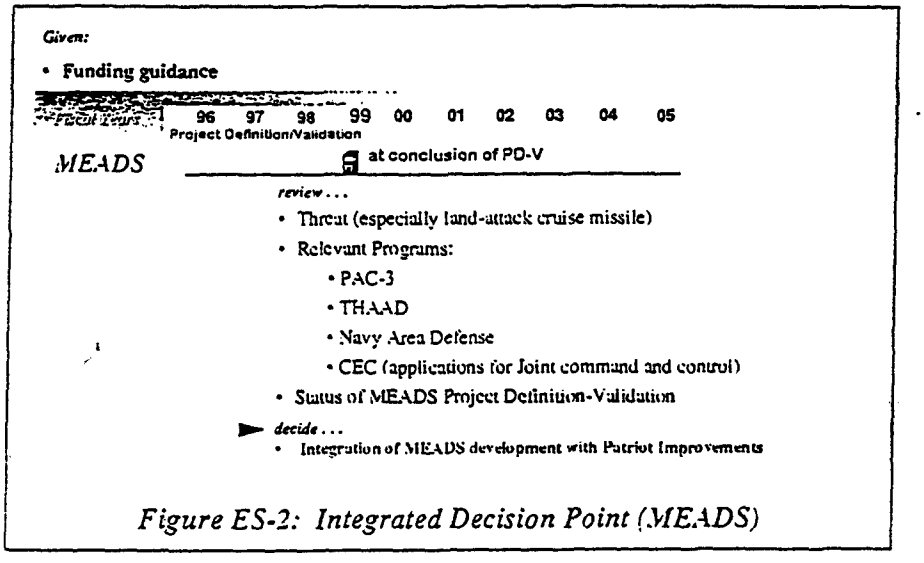


Figure ES-2: Integrated Decision Point (MEADS)

By identifying these optimal points in program development, decision makers can defer critical decisions on system trade-offs until threat and technological capabilities become more clear. Doing so avoids the unnecessary risk associated with making fielding decisions prematurely. This methodology can be implemented while staying within the mandated $2 billion per year.

Recommendations on FY 1996 Decisions

In order to provide joint commanders the active defense capabilities they need while staying within the budget constraints, the following measures should be initially applied to existing and proposed programs:

- plan to procure 600 PAC-3 missiles instead of 1200 (no delay in initial operating capability (IOC))
- plan to procure one battalion of THAAD instead of two (no delay in IOC)
- plan to recapitalize some PAC-3 funding into PAC-4, while supporting MEADS through Project Definition-Validation (PD-V)
- plan to initiate Navy Theater Wide in FY 2000 (delays IOC one year; retains proposed full operating capability)
- consider supplementing USAF funding of boost-phase intercept technology development

Then make integrated (multi-system) programmatic decisions while retaining the systems necessary to meet required capabilities and continuing significant technology development (e.g., boost-phase intercept).

If implemented, these measures change the funding profile to meet the guidance (see Figure ES-3). (The funding portrayed assumes development of PAC-4 instead of

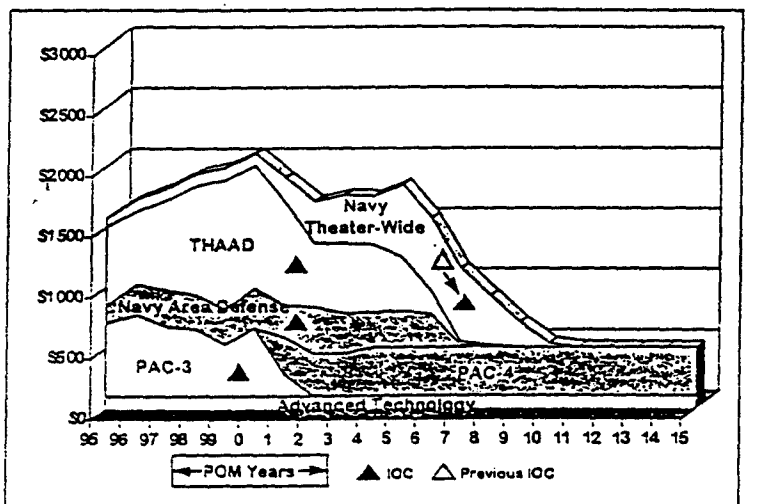


Figure ES-3: Meets Funding Guidance

MEADS. The decision whether to develop MEADS or PAC-4 should be made at the decision point indicated in Figure ES-2. Inclusion of funding for MEADS PD-V (FY-1996-1999) would not significantly change the funding profile.)

Conclusions

Affordability and timeliness are addressed through the methodology described in this study by leveraging existing programs. Continuing to fund these programs and to develop the most promising new technologies provides a hedge against accelerated threat development, while allowing program adjustments if threats do not materialize as projected. Deterrence is served as well: an adversary is unlikely to spend scarce resources on theater missiles destined to be ineffective as a result of this broad-based, flexible approach.

CHAPTER 1:–INTRODUCTION

A Theater Missile Defense Integration Study: Reviewing Priorities for Acquiring Active Defense Systems

The Director for Force Structure, Resources and Assessment (J-8) of the Joint Chiefs of Staff chartered this *Theater Missile Defense Integration Study* to support a *review of priorities for acquiring active defense systems*. Specifically, the objective was to report on issues related to the ongoing Office of the Secretary of Defense (OSD) and Service-related studies on theater missile defense (TMD) capabilities and future requirements. Initially, a synthesis of recent TMD studies, this project expanded to review a broad array of research materials. Supplementing that research were interviews of missile defense experts and system proponents.

This final report describes the study's analytical process. In addition, the report makes recommendations and describes a methodology that supports integrated active defense systems acquisition. The intent is to provide a planning document to help focus the Joint Staff as it executes its responsibilities described in *Department of Defense Directive 5000.1: Defense Acquisition.*

The appendices are comprised of research materials and references which should be useful in the continuing effort to determine priorities. Appendix A discusses key issues; Appendix B (classified and issued separately) summarizes selected studies, focusing on relevant issues; Appendix C is a collection of budget variations; Appendix D is a list of missile defense experts interviewed during this study; Appendix E is an annotated bibliography; and Appendix F is a list of acronyms.

Parenthetical citations in the text refer to items in Appendix E.

Rationale for an Integrating Study:
A Synthesizing Effort

More than one interviewee questioned the need for *another* TMD study. The sheer number of studies, however, argued strongly for an integrating study to synthesize the perspectives of the numerous organizations having TMD responsibilities. Examples of these studies are shown in Figure 1-1.

- Report of the Commission on Roles and Missions
- Ballistic Missile Defense Capstone ORD
- Cruise Missile Defense ACTD
- MIT Lincoln Labs Attack Operations Study
- Report of Defense Science Board on TMD
- TMD Capstone COEA
- TMD Command and Control Plan
- Report of NATO Defense Group on Proliferation
- Joint Strike Integration/Attack Operations Reports
- Boost-Phase Intercept Study
- Navy TBMD COEA
- Joint Threat/Mission Priorities Assessment

Scope Broadened to Include 100+ Documents & Interviews

Figure 1-1: Theater Missile Defense Studies and Analyses

Active defense operations are by nature complementary. Theater missiles rapidly traverse areas of operation. As a result, time-tested principles of defense in depth and mutual support mandate an integrating approach for acquiring systems. The methodology described in this study reflects that point of view.

Indeed, the first quarter of fiscal year (FY) 1996 teemed with debate. *The central issue had become determining priorities for theater missile defense active defense system acquisition.* The context was the upcoming budget processes--the FY 1997 budget, as well as the FY 1998-2003 Program Objectives Memorandum (POM). Within this context, three factors combined to generate a sense of urgency: significant events in active defense system development, the comprehensive review of active defense systems priorities by the Joint Requirements Oversight Council (JROC), and an increasing sense of fiscal constraint.

CORE PROGRAMS
- PAC-3
- Navy Area Defense
- THAAD

ADVANCED CONCEPTS
- Navy Theater Wide
- Corps SAM/MEADS
- Boost-Phase Intercept

Significant events had occurred in 1995. ... Patriot Advanced Capability-3 (PAC-3), for example, was in engineering and manufacturing development (EMD). The Theater High Altitude Area Defense (THAAD) system was in flight testing. At Fort Bliss, Texas, the Army activated its first THAAD unit, which will operate the User Operational Evaluation System (UOES).[1] Preparations were underway for Navy Area Defense Milestone II (the beginning of EMD). With three Lightweight Exoatmospheric Projectile flight tests completed, the Navy advocated initiating a Navy Theater Wide program.

In 1995, cruise missile defense received increased attention. The U.S. was preparing to sign a Medium Extended Air Defense System (MEADS) memorandum of understanding with Germany, France, and Italy. OSD directed the Services to conduct cruise missile defense studies. (Marine Corps Hawk was undergoing modifications to make it capable against ballistic missiles, but the active air and missile defense of marine forces was expected to migrate to the Army as core and advanced concepts become operational.[2])

This integration study did not consider funding alternatives for the Hawk system. There is approximately $20 million in the Ballistic Missile Defense Organization (BMDO) budget in FY 1997 for the TPS-59 radar and Hawk modifications. These improvements will provide a theater ballistic missile defense (TBMD) capability for the Marine Corps. This amount of funding was considered too small and too short in duration to be considered for alternative strategies.

Research and development on boost-phase intercept (BPI) technology development continued, as well. Air Force officials indicated their Service's intent to continue airborne laser technology development. Interest in developing a space-based laser remained high, while support and funding for the airborne intercept (kinetic energy) demonstrations decreased. *In short, core programs were making significant progress and some advanced concepts were being considered for program initiation.*

In May of 1995, the Commission on Roles and Missions reported on its effort to provide direction to the Department of Defense (DoD). The commission made two observations particularly relevant to this study. First, it cited the need for increased Joint Staff involvement in integrating the requirements process:

> Most studies conclude, as we have, that the primary problems in weapon systems acquisition are traceable to inadequacies in the early phase of the requirements determination process. The lack of a unified concept and analysis of warfighting needs is the critical underlying problem. (Ref. 133)

The report also emphasized *mission-driven* requirements: the Services should provide capabilities required by the commanders in chief (CINCs).

The themes above were conspicuous in the JROC's comprehensive review of active defense priorities. Driving that review was the need to constrain funding. (THAAD, in particular, was under scrutiny. In addition, there was a desire to examine trade-offs between attack operations and active defense.) The influence of the Roles and Missions Commission's advice to make "early decisions on which competing ideas should be developed" was evident (Ref. 133). This theme shaped much of the work conducted during the JROC's TMD review.

The review was positioned to influence the upcoming budget processes. In this regard, there was a specific concern with out-year projections for the composite funding of active defense systems. If all systems proposed by the Services were to be funded, the out-year expenditures would approach $3 billion per year, as shown in Figure 1-2.[3]

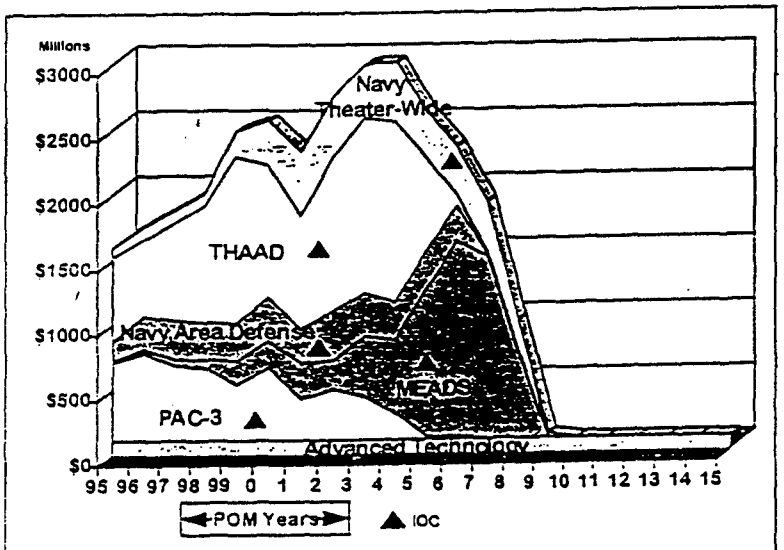


Figure 1-2: Funding for All Proposed Programs

The guidance that this funding level was excessive, combined with the conclusion of phase one of the OSD-directed *TMD Cost and Operational Effectiveness Analysis (COEA)*, fueled debate on the relative effectiveness of systems. *There was a sense that major programmatic decisions were imminent*: which systems to continue, which to initiate, which to defer, and which to eliminate from consideration.

The Recommendation:

Continue on Course--with Some Adjustments

The active defense systems advocated by the Services and the BMDO are *required.* Providing these capabilities will provide the CINCs active defenses pacing the anticipated threat. If supported fiscally, existing systems and developing technologies will reasonably cope with the threat. When fielded, the core systems will counter the more predominant near-term theater missile threats. The advanced concepts will defend against emerging medium-range ballistic missiles (MRBM), land-attack cruise missiles (LACM), and advanced ballistic missiles.

A Methodology for a Continuing Review of Priorities:

Integrated Active Defense Decision Points

Chapter 4 describes an integrated decision-point methodology. It identifies points where the threat, requirements, force structure, and programmatics should be reviewed and integrated acquisition decisions made. The terrain for this decision-point roadmap is a composite picture. It incorporates a low-risk threat assessment, a requirement for a robust package of active defense capabilities, and programs and concepts as described below. At each decision point, the scope and content of programs are reviewed--within the relevant TMD context. The study also identifies major issues requiring resolution in conjunction with integrated decisions. This methodology preserves options, while monitoring cost-per-unit increases. The initial planning adjustments required to implement this methodology include the following:

- ☞ Allow PAC-3 to proceed as planned, but consider reducing missile procurement and shifting funds to a more mobile and improved ground-based active defense (no delay in PAC-3 initial operating capability (IOC)).

- Allow **Navy Area Defense** to proceed as planned, but make procurement decisions in coordination with PAC-3 (no delay in IOC).
- Consider reducing **THAAD** procurement, but decide within the acquisition process (no delay in IOC).
- Determine how to use **Ground-Based Radar** (GBR) to enhance capabilities of all systems: attack operations, active defense, and passive defense (no delay in IOC).
- Defer **Navy Theater Wide** program initiation decision until 1998, but provide funding for continued technology development until program initiation in FY 2000 (delays IOC one year). Fund procurement to achieve current proposed full operating capability.
- Begin planning to develop a **Patriot Advanced Capability-4 (PAC-4)**[4] (improved PAC-3). However, continue to support MEADS through Project Definition-Validation: define PAC-4, which could serve as alternative to MEADS; study interim solutions for cruise missile defense and tactically mobile ballistic missile defense of maneuvering forces; consider a combination of Advanced Concepts Technology Demonstrations (ACTD) and PAC-3 product improvement.
- Obligate and protect technology development funds to identify and develop the most promising **BPI** development.

This strategy provides flexibility and adaptability. It expeditiously puts initial capabilities into the hands of operators; it facilitates determining procurement quantities and refining design criteria as capabilities and the threat trends are better understood. Even with a $2 billion funding cap on active defense systems spending, there is no pressing need to eliminate systems from consideration. Furthermore, caution should be exercised in imposing program delays designed to establish conditions for competitive analysis or tests. Permitting the *sequential development of the full range of required capabilities is the prudent approach.* It is, as well, fiscally responsible. This approach sets the conditions for giving the CINCs what they need when they need it.

CHAPTER 2: REVIEW OF REQUIREMENTS

Supporting the National Security Strategy:
A Variety of Roles for the Military

Two major themes characterize the forecast for the future: uncertainty and variability. On this topic, the President's national security strategy states CINCs will require "*balanced* U.S. forces . . . to provide a *wide* range of *complementary* capabilities . . . to cope with the *unpredictable* and *unexpected*" [emphasis added] (Ref. 120). Similarly, the *Report of the Commission on Roles and Missions* predicts "continued and probably dramatic change," adding "the nature, location, scope, characteristics, and timing of military operations in the future remain uncertain" (Ref. 133). A materiel development strategy designed to cope with such conditions needs flexibility and adaptability.

Future Joint Military Operations:
Increased Emphasis on the Political Dimension

In the future, joint and multi-national operations will be expected to establish order and stability, supporting the growth of democracy and economic advancement. The current operation in Bosnia is such a situation (see Figure 2-1). Given such missions, the political dimension will be critical. Alliances may be

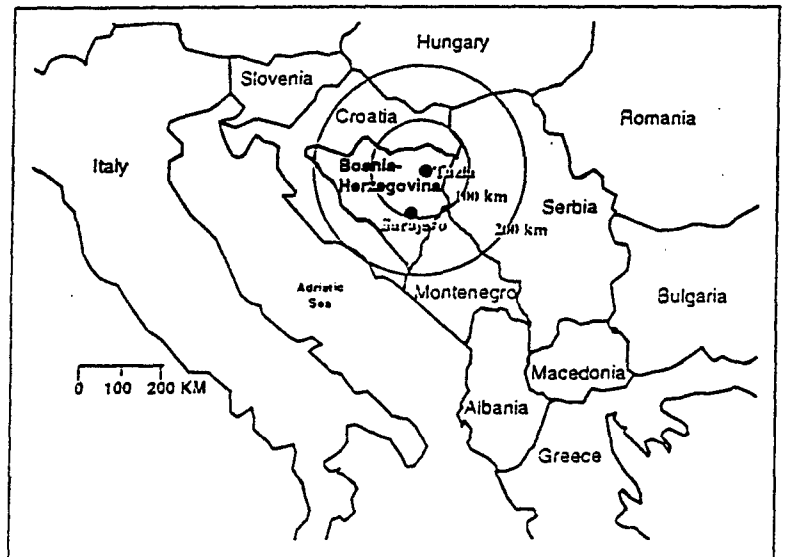


Figure 2-1: A Joint/Multi-National Operation in 1996

politically complex, even fragile. The U.S. will continue to participate in multi-national task forces and military coalitions as seen during the war with Iraq and the ongoing mission in Bosnia. Obtaining public and congressional support for future operations will continue to require clear articulation of military objectives and well-defined political goals. Successful theater missile attacks could undermine either requirement.

Future adversaries will probe the seams of the world order, using unpredictable military tactics. *Joint Publication 3.0: Doctrine for Joint Operations* postulates:

> Regional challenges will often involve an adversary whose system of beliefs interprets differently such fundamental ideas as right and wrong, the value of human life, and the concept of victory and defeat. What appears to be fanatical to U.S. forces may be completely rational to our opponent. (Ref. 75)

Further complicating the future will be the appearance of new threats (in terms of technology, as well as politics). As evidenced in the Gulf War, threat predictions are complex. Future challenges to the industrial base similar to the one met by Patriot can be anticipated. The Army's history of Patriot operations in Desert Storm notes:

> It soon became apparent that the threat was not exactly as predicted. The missiles the Iraqis fired were different from the Soviet Scud missile, which the Patriot was designed to defeat. The Iraqis had modified their Scuds to carry more fuel and smaller warheads in order to greatly extend their range. The Iraqi Scud variant that Patriot faced in Israel and Saudi Arabia was a much faster target than expected--something on the order of 5,000 miles per hour as it came down over its target. The poorly modified Scud often broke apart, confronting the Patriot system with multiple targets consisting of the warhead and large pieces of debris. This was a target Patriot was neither designed nor developed to defeat. (Ref. 123)

Future threats may also appear with little warning, in the hands of rogue leaders, and beyond the influence of political or economic measures. If unchecked, proliferation of limited numbers of high-technology theater missiles is certainly possible. The Commission on Roles and Missions also counseled vigilance against military threats from former Soviet states armed with nuclear weapons. If available, developing nations will seek to buy weapons of mass destruction and their delivery vehicles as a relatively inexpensive but equalizing capability. *The Defense Planning Guidance: FY 1997-2001* echoes this concern, asserting that countering weapons of mass destruction is the "highest priority challenge" of theater ballistic and cruise missile defense (Ref. 119). Figure 2-2 illustrates the magnitude of effects that weapons of mass destruction could have over the Washington, D.C. area.

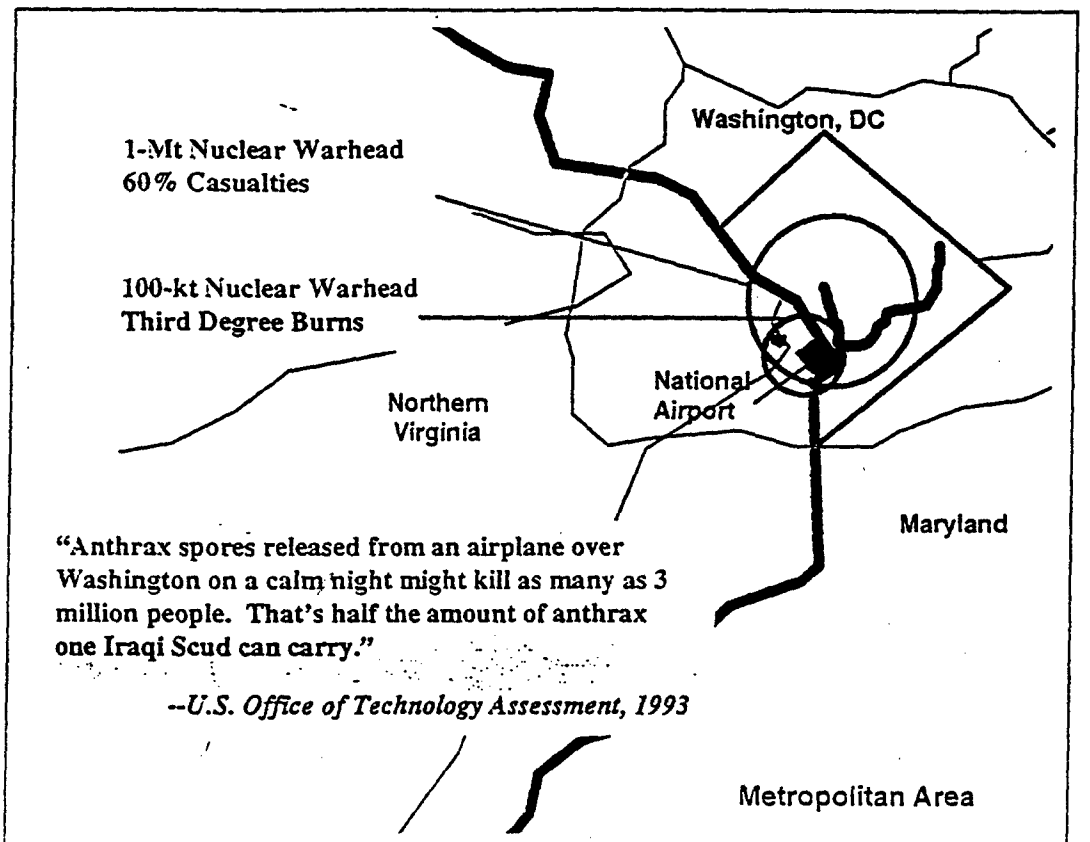


Figure 2-2: The Magnitude of the Threat[5]

The Role of Theater Missiles:
Avoiding Decisive Combat

The following force projection scenario outlines the options provided by theater missiles. Having provoked a U.S.-led military response, an overmatched adversary is likely to avoid decisive combat, while attempting to secure economic, political, or geographic objectives. Initially, he may attempt to undermine political support for deployment. He could do so by attacking population centers or ports of embarkation. Another option is to attempt to deny expeditious lodgment by attacking air or seaports of debarkation, perhaps inflicting mass casualties. If lodgment and build-up succeed, theater missiles could disrupt offensive operations by attacking concentrated or maneuvering forces or logistics points (see Figure 2-3). Conventional warheads or one or more weapons of mass destruction could effectively do these missions. Mass casualties among civilians or deployed forces would cause reassessment of coalition objectives and could cause dissolution of political resolve and military credibility (Ref. 111).

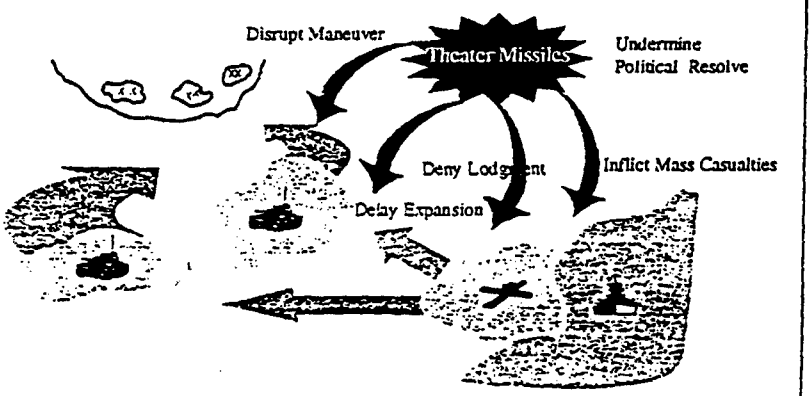


Figure 2-3: Threat to Force Projection

Theater missile attacks can come from a distance and from multiple directions. If available, longer-range missiles enable nations to participate in a conflict without deploying to the combat zone. This capability could facilitate an adversary's forging of a geographically dispersed, politically complex alliance. In short, missile warfare expands theater operations into the strategic environment, making the political and military dimensions

virtually inseparable. As shown in Figure 2-4, Iraq probed such a seam in world politics, launching ballistic missiles throughout the Gulf region during the war.

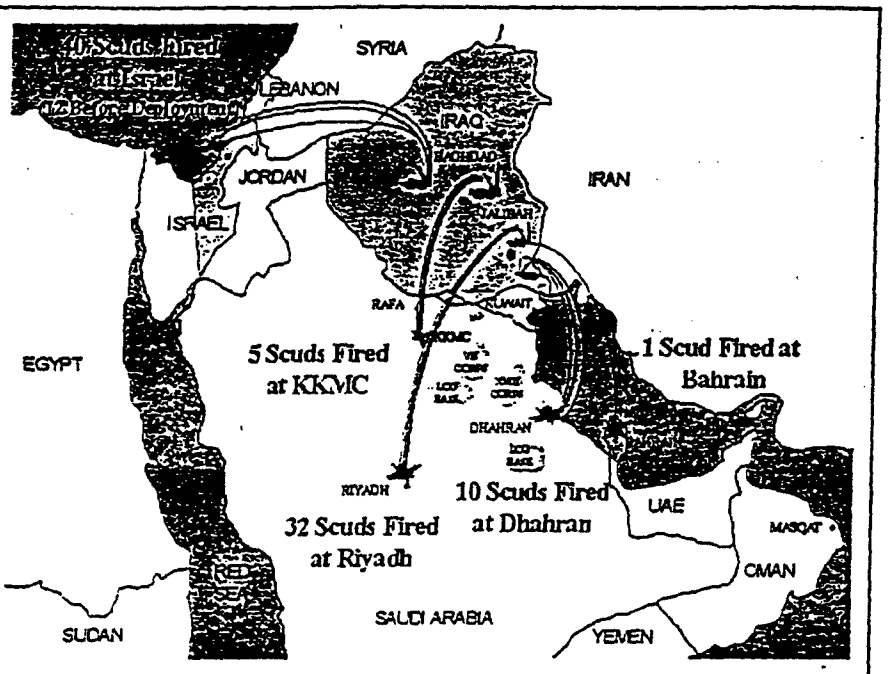


Figure 2-4: Missile Warfare During Desert Storm (Ref. 1)

The message in the high-level guidance and requirements documents seems clear. It is emphasized in the *Defense Planning Guidance*: the nation will look to the military to provide "the military wherewithal to credibly underwrite its commitments" (Ref. 119). This expectation, coupled with the consequences of ineffective defenses against weapons of mass destruction, argues for a synchronized requirements/acquisition strategy, designed to counter the full arsenal of theater missiles. In effect, this synchronization strategy should allow an adversary no free ride when considering theater missile options. The advisable attitude toward characterizing the threat, the first step in planning any defensive endeavor, seems appropriately highlighted in the Defense Science Board's report: the requirements process should "anticipate not merely validate" the threat, while keeping in mind that "absence of evidence [of a particular threat] is not necessarily evidence of absence" (Ref. 130).

Categorizing Theater Missiles:
From the Active Defense Systems Perspective

This study recognized that active defense interceptors need to negate the effects of weapons of mass destruction in order to protect ground-based assets and forces. The materiel development programs underway and proposed are being assessed against this need. For example, the Army's selection of hit-to-kill technology reflected the concern with the full range of weapons of mass destruction. As sea-based systems develop, the Navy will continue to assess lethality. In designing BPI systems, ensuring the shortfall of lethal debris is a major objective of combat and materiel developers. Given this requirement to negate warhead effects, the following threat definitions focus on delivery vehicles.

See Issue 1: Lethality page A-3

This study defined threat delivery vehicles from the perspective of the active defense materiel developer. The primary time frame of interest was 1996 to 2005 with the post-2005 period a follow-on concern. The Joint Staff's interest in influencing the FY 1998-2003 POM drove this scoping of the threat. Given these parameters, five significant threat categories exist. (*Significance*, in this case, means the threat requires a particular type of active defense materiel solution.)

- short-range ballistic missiles (SRBMs)
- medium-range ballistic missiles (MRBMs)
- advanced ballistic missiles
- anti-ship cruise missiles (ASCMs)
- land-attack cruise missiles (LACMs)

The categories derive from a balanced consideration of four factors: the *United States Space Command (USSPACECOM) Ballistic Missile Defense (BMD) Capstone Operational Requirements Document (ORD)*, treaty considerations, the design parameters of active defense systems under development or in concept form, and the shaping realities of physics. Physics is the foundation; it has driven system design possibilities and ORD definitions.

Short-Range Ballistic Missiles:
The Predominant Threat Today

Theater ballistic missiles launched from ranges up to 1,000 kilometers are short-range. Core programs will be highly capable against this threat. Threats with ranges greater than 1,000 kilometers significantly stress endoatmospheric interceptors (see Figure 2-5). This degradation results from a combination of

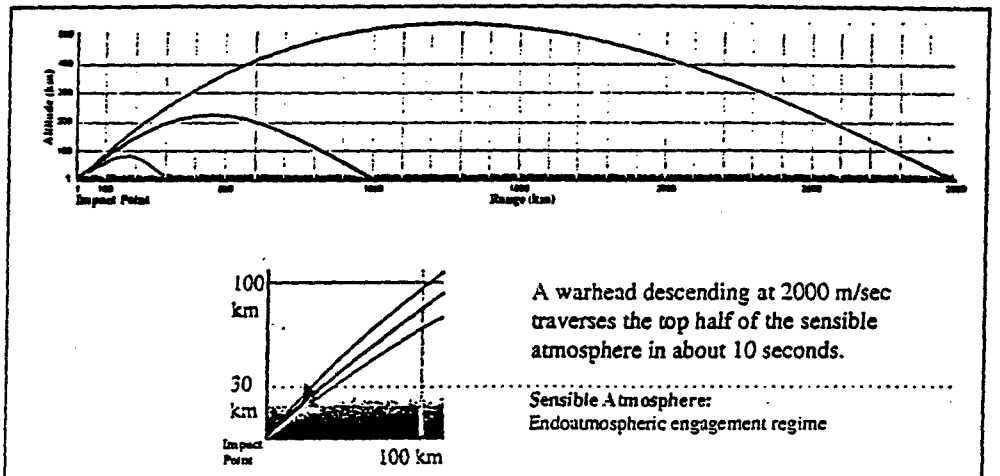


Figure 2-5: Endoatmospheric Engagement Regime

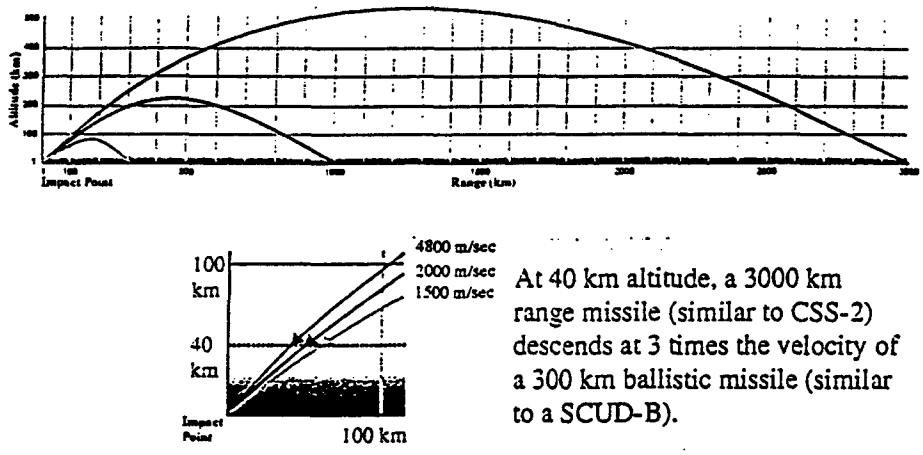
factors. Among them are the 30-kilometer upper boundary of the sensible atmosphere, the velocities of active defense interceptors, the requirement to enforce a keep-out altitude, and the desire to protect a significant footprint. Single-shot probability of kill values for guided missiles are also a consideration.

Short-range missiles, reportedly totaling well over 8000 in the world-wide inventory, include the numerous Scud variants (the most proliferated ballistic missile) and the accurate SS-21 (which operates in the 70 to 120-kilometer range and has a circular error probable of about 50 meters). The North Korean *No Dong-1*, a Scud-based, 1000-kilometer missile currently under development, operates from the upper end of the short-range spectrum. Production and proliferation of such missiles is predicted to continue through the end of the century.

Medium-Range Ballistic Missiles: Beginning to Emerge

Generally, as ballistic missile ranges increase, so do their maximum altitudes and terminal velocities (see Figure 2-6). The MRBM (1,001 to 3,000 kilometers) descends with significantly greater velocity than shorter-range ballistic missiles. As a result, the intercept solution is more demanding than those defining the short-range intercept problem (however, increasing engagement range or conducting ascent-phase intercepts provides some relief).

See Issue 2: Medium-Range TBM Threat page A-7



At 40 km altitude, a 3000 km range missile (similar to CSS-2) descends at 3 times the velocity of a 300 km ballistic missile (similar to a SCUD-B).

Figure 2-6: Descent Velocity as a Function of Range

To maintain a keep-out altitude and enable multiple sequential shot opportunities (following kill assessments), initial intercepts must occur at altitudes above the atmosphere. So, to provide a robust defense capability against MRBMs, an interceptor must engage at higher or exoatmospheric (80+ km) altitudes and extended ranges. Defense in depth and protected area footprint against SRBMs with ranges greater than about 300 kilometers improves, as well, if the interceptor operates above the sensible atmosphere.

Exoatmospheric interceptors use small thrust jets to maneuver to the vicinity of intercepts rather than aerodynamic control surfaces. In addition, their infrared seekers have different cooling requirements than those of endoatmospheric interceptors with infrared seekers. Target/warhead discrimination tends to be simpler in the endoatmospheric regime than at high altitudes. Descending through thickening atmosphere, a warhead tends to separate from other missile components or debris.

Although not yet widely-produced or proliferated, MRBMs are currently emerging, especially among the so-called *rogue* states. The Iranian *Tondar 68* will operate from ranges around the 1,000-kilometer transition point separating short from medium-range. The 1,500-kilometer North Korean *No Dong-2*, currently under development, is in the low end of the medium-range category, while the Chinese *CSS-2* operates at the upper extent, about 3,000 kilometers. Also among the countries showing either production or procurement interest in this class of ballistic missiles are Syria, Libya, India, and Pakistan.

Advanced Ballistic Missiles:
Counter-Countermeasures

The third category of theater ballistic missiles is termed here the *advanced TBM*. Advance TBMs employ counter-countermeasures designed to defeat terminal defenses. Such measures could include payload fragmentation. Penetration aids (penaids) or counter-countermeasures could present terminal defenses highly complex intercept problems. Penaids may delay detection or degrade track quality, significantly complicate target discrimination, or create an uncertain aimpoint (Ref. 122). Another type of advanced ballistic missile may deliver multiple warheads (similar to a multiple-reentry-vehicle-equipped intercontinental ballistic missile), overwhelming terminal defenses, or making them unacceptably expensive to operate. The target discrimination challenge caused by the inadvertent break-up of the Iraqi *Al Hussein* missile body during terminal flight illustrates a key characteristic of this type of ballistic missile. The imminence of engineered versions of advanced ballistic missiles is a topic of interest throughout the TMD community.

See Issue 3: Early Release of Submunitions page A-10

Anti-Ship Cruise Missiles:
A Continuing Threat to the Fleet

Two significant categories of cruise missiles exist. The first, the ASCM has, for some time, been a top air defense priority for the Navy. Large objects such as ships stand out in the relatively clear picture available in the seascape. The absence of the navigational problems and background clutter caused by terrain variation has made ASCMs, in some ways, less challenging to engineer than land-attack cruise missiles. The need for robust active defense against ASCMs such as the *Exocet* is well established. The

Argentines' sinking of the British *HMS Sheffield* during the Falklands War over a decade ago is the most striking evidence supporting this continuing mission need. Anti-ship cruise missiles are widely produced and proliferated; some forty nations have ASCMs in service. The Navy will continue to develop and acquire systems to defeat this threat.

Land-Attack Cruise Missiles: On the Threat Horizon

The second cruise missile category is the LACM. Accurate navigational guidance and positioning data are becoming available at affordable prices. But, the availability of systems integration technology is less certain (Ref. 128). As demonstrated by the U.S. in Operation Desert Storm, the LACM will provide an adversary a highly accurate, stressing attack option. While LACMs can fly many different flight profiles (from high and fast to low, slow, terrain-following), what makes the LACM so stressing is its capability to fly a route masked by terrain. In addition, the earth's curvature limits the detection range at which a ground-based radar can detect a low-flying LACM (see Figure 2-7). These difficulties,

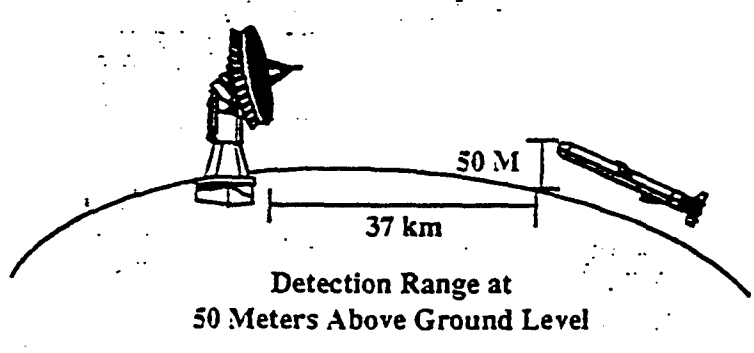


Figure 2-7: The Earth Curvature Problem

when compounded by the potential to deliver weapons of mass destruction, make extended-range (beyond-line-of-sight) intercepts a requirement for a robust defense. Such cruise missiles are best destroyed before they overfly friendly troops or territory.

Although not widely proliferated or produced in militarily significant numbers, the LACM is an *emerging* threat. The

technologically sophisticated French *Apache* is expected to be in service in 1997. (Air-delivered cruise missiles are a significant threat today--especially if air supremacy is not assured.) Scott McMahon and Dennis Gormley report in their book *Controlling the Spread of Land-Attack Cruise Missiles* that the Russian-built *AS-15 Kent* has been widely offered for purchase (Ref. 128). Less expensive to build and operate than ballistic missiles, the LACM is predicted to supplant the ballistic missile in the twenty-first century as the theater missile of choice among developing nations.[6]

Required Active Defense Capabilities:
Providing the CINCs What They Need When They Need It

See Issue 4: Multi-Tier Concept page A-11

See Issue 5: BMDO & Cruise Missile Defense page A-14

Given the composite threat picture above, what are the active defense capabilities required to protect forces and other assets against attack? The *USSPACECOM BMD Capstone ORD*, dated 9 December 1994, specifies ballistic missile defense requirements. While acknowledging the role of integrated multi-element ballistic missile defense, the ORD also requires robust, multi-tier active defenses, "capable of graceful degradation in performance against concentrated attacks and [having] options for system growth" (Ref. 98). The need for LACM defenses and defense against very short-range ballistic missiles appears in the JROC-validated *Theater Missile Mission Need Statement* of 1991, which directs development of theater missile active defenses to protect the "force." The BMDO's *1995 Report to Congress on Ballistic Missile Defense* summarizes the *Theater Missile Defense Mission Need Statement* as follows:

> . . . to protect U.S. forces, U.S. allies, and other important countries, including areas of vital interest to the U.S., from theater missile attacks. The TMD mission includes protection of population centers, fixed civilian and military assets, and mobile military units. (Ref. 137)

The Other Elements of Joint TMD:
Supporting not Replacing Elements

Active defenses do not operate in isolation. The Joint Staff's draft assessment, *Threat and Missions Priorities*, strongly endorses the value of deterrence as well as synergistically applying all elements

of joint TMD--attack operations; passive defense; and command, control, communications, and intelligence (C3I) (Ref. 144). The tenor of the current studies, however, is that attack operations generally will not eliminate the need for active defenses. In some theaters, first strike authority will be denied. In many, launchers will be concealed. Often, weather will temporarily limit operations.

The body of analysis stresses such complications and the situational aspect of attack operations. One example is the Massachusetts Institute of Technology Lincoln Laboratories' *Attack Operations Study*, which notes the challenges of sophisticated attack operations characterize other expansive, cross-Service, joint endeavors. Warfighting challenges ". . . the exquisite functioning of a large, complex system involving very capable electronic systems sensor-processing technology, command and control, and advanced weapons" (Ref. 138). Army studies reinforce such themes, noting "the impact of attack operations varies significantly as a function of multiple situational factors" and that "attack operations take time to take effect" (Ref. 53). Over extended periods, however, attack of infrastructure and the suppressive value of air sorties can make a major supporting contribution.

See Issue 6: Attack Operations page A-17

Similarly, optimized missile attack warning and other forms of passive defense cannot eliminate the need for active defenses. To rely solely on active defense could cause serious demoralization. Certainly, concealment, hardening, mobility, early warning, and other aspects of passive defense are helpful. However, there is a psychological synergy that develops with the presence of active defenses. Writing about the British experience during World War II, a study by the Centre for Defence and International Security Studies related:

> The British people understandably found it extremely difficult, physically and psychologically, to cope with attacks when they knew they were undefended. But they were able to cope, despite sometimes heavy casualties, when they knew they were being defended.[7]

Active Defense During the Phases of a Joint Operation: The Time Dimension

A capability that is unemployable or too late to arrive in the theater is no capability. The *BMD Capstone ORD's* brief comment summarizes the composite view emerging from a study of the majority of the available documents: "TBMD systems and BMD supporting systems must be employable in a variety of situations ranging from protection against a simple unauthorized launch to protection of forces deploying into a theater" (Ref. 98). It is logical to extend this requirement to cruise missiles as well. So, completing the requirements laydown demands considering the time dimension. The following description reflects a composite or generic force projection scenario--one that generates a full range of capabilities requirements. The primary documents here are *Joint Publication 3.0: Doctrine for Joint Operations* and *Joint Publication 3.01-5: Doctrine for Joint Theater Missile Defense.* Considering the operational phases outlined in Figure 2-8, this study developed three phases significant to active defense capabilities requirements:

- Prehostilities (to include forcible entry)
- Lodgment (build-up and expansion of the force)
- Decisive combat (in particular, offensive operations)

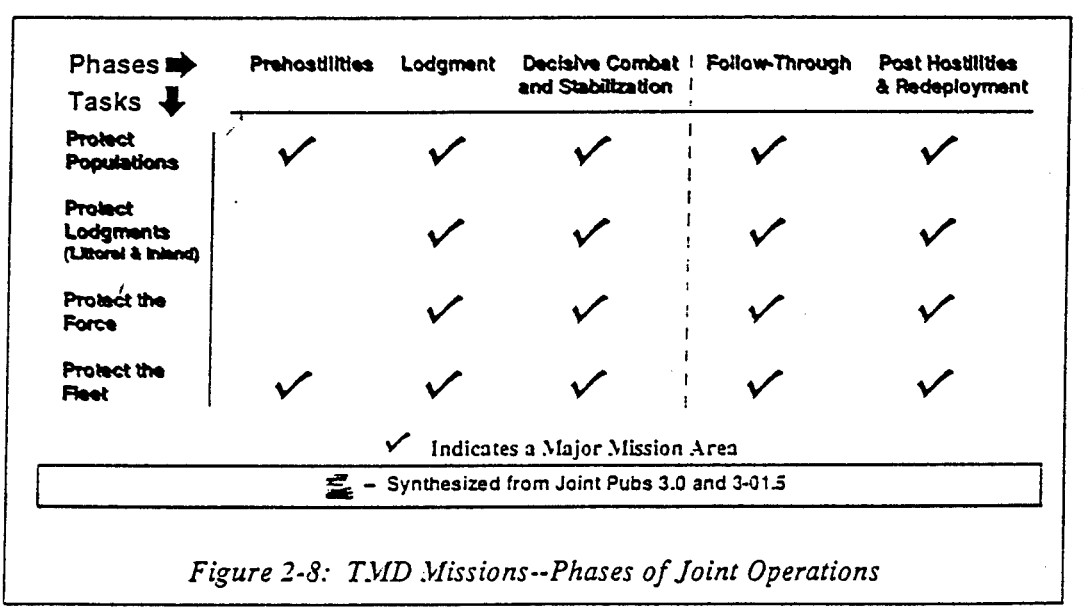


Figure 2-8: TMD Missions--Phases of Joint Operations

Prehostilities:
Operations as a Theater Develops

While critical assets, areas, and populations may be defendable by forward or predeployed defense systems during prehostilities, rapidly developing situations in an immature theater may cause this option to be overcome by events. Forward deployment or predeployment of active defense systems may also require warning time and/or host nation approval. Forcible entry operations, in particular, will require airborne, space, and/or sea-based active defense. Because air and space-based concepts and technologies are *relatively* immature, those options are considered beyond the *primary* scope of this study. (The *BMDO Report to Congress* states the intent to demonstrate kinetic energy boost-phase intercept technology in FY 1999. The report also notes the Air Force's intention to conduct a flight demonstration of a limited operational airborne laser capability in FY 2002 (Ref. 137).) As laser technology and operational considerations become more thoroughly defined, however, such options will provide additional employment flexibility. Even then, however, airborne and overhead systems will be subject to constraints such as weather conditions and challenging logistics requirements. In the absence of ground-based active defense systems, a sea-based capability to defend against all categories of theater missiles is required.

See Issue 7: BPI page A-20

Lodgment:
Building Combat Power Ashore

During lodgment and onward movement into tactical assembly areas or into fighting positions, a joint sea-based and ground-based active defense is required. As the force expands, active defenses will become limited resources. Protecting lines of communication and littoral regions with sea-based active defense will permit ground-based active defense of assets and forces deployed inland. The following incident report in *Scud Alert! The History, Development, and Military Significance of Ballistic Missiles on Tactical Operations* illustrates the consequences of threats to the littoral: "Scud attacks on Jabayl and Damman [during the Gulf war] caused four civilian ship captains to pull back out to sea, delaying the unloading of combat elements of the much-needed VII Corps" (Ref. 112). In the future, a particularly challenging aspect of this requirement will be the need to conduct beyond-line-of-sight cruise missile defense to destroy weapons of mass destruction over enemy territory. This need will grow as

adversaries acquire cruise missiles with chemical, biological, or nuclear payloads.

Decisive Combat:

Protecting Maneuvering Forces During Offensive Operations

An additional operational requirement develops with the beginning of large-scale or rapidly advancing offensive operations (see Figure 2-9). Because forward maneuvering forces are likely to outrun active defenses that are not tactically mobile or survivable, an additional ballistic missile defense requirement exists. Whether or not ballistic missiles are militarily significant was a topic of debate as the Gulf War was analyzed. While one missile may be insufficiently accurate to hit a point or hardened target, mass attacks, especially if delivering weapons of mass destruction, would be and have been a constraining factor--a distraction to commanders at the very least. In a post-war interview, the VII Corps commanding general "expressed particular concern about chemically-armed ballistic missiles landing on his soldiers 'in the breach'" (Ref. 112).

e Issue 8: Threat to er Forces page A-22

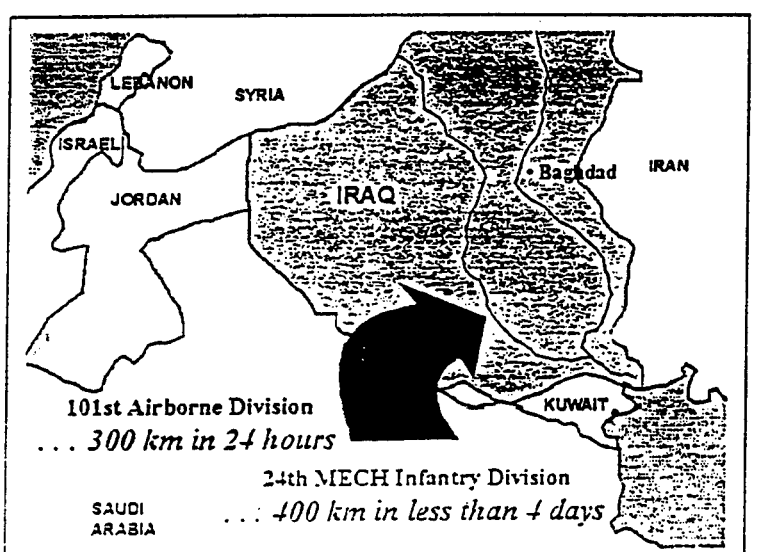


Figure 2-9: Offensive Operations During Desert Storm

ctive Defense During Post-Hostilities

rotecting assets during stabilization, follow-through, and post-ostilities could increase area active defense requirements in terms f force structure and sustainability over time. Consider, for ample, current Patriot deployments in Korea and the Middle ast. The basic capabilities required, however, will be as escribed during the phases discussed above. In summary, these apabilities should be provided, as portrayed out in Figure 2-10:

sea-based active defense against short and medium-range ballistic and anti-ship cruise missiles

ground-based active defense against short and medium-range ballistic and land-attack cruise missiles

tactically mobile ground-based active defense against short-range ballistic missiles and land-attack cruise missiles

boost-phase intercept against short and medium-range ballistic missiles

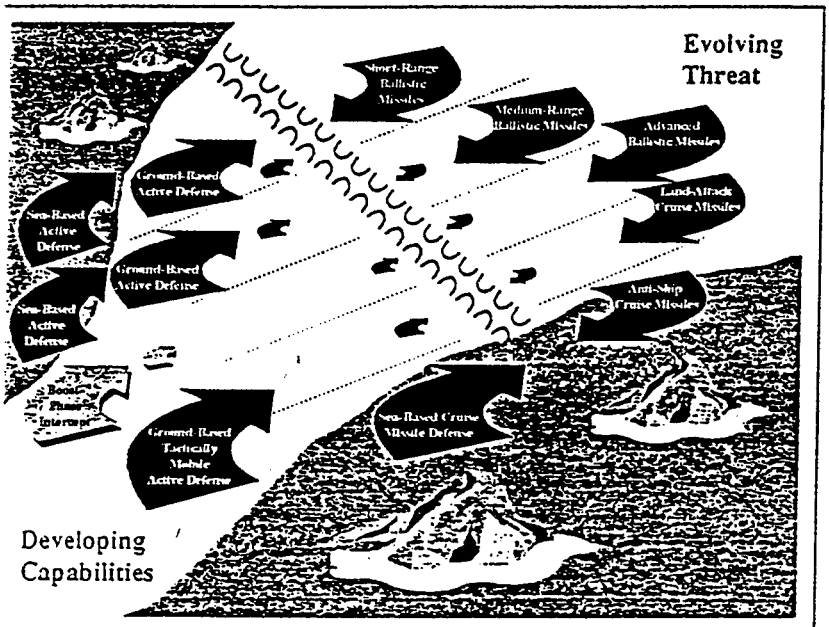


Figure 2-10: Theater Missile Order of Battle
A Snapshot in 1996

(Certainly, the tactically mobile ground-based system could fulfill the requirement to defend static assets. That capability, however, will not be developed before less mobile capabilities such as PAC-3. See the discussions of PAC-4 and MEADS in Note 4, p. 43 and Issue 10, p. A-27.)

The Services and BMDO have proposed materiel solutions that will fulfill these requirements. Finding the funds to acquire the associated systems is the challenge. That challenge is addressed in Chapter 3.

Defer Decisions:
Avoid Delaying IOCs

Ideally, the nation would robustly fund and expeditiously field all required capabilities. The pace of enabling technologies would be the limiting factor. That approach, however, is too expensive. So the study team looked for ways to reduce the cost of systems without incurring additional operational risk. One option was to defer procurement decisions. Another was to identify mission areas where additional time could be allocated for technical risk reduction. In all of this, the primary concern--other than bringing cost in line with the guidance--was not to delay initial operating capabilities.

Given current threat assessments, the existing sequence of acquisition programs is appropriate. The core programs address the known threat; advanced concepts, if developed, will defend against emerging threats. Of particular concern, however, is the proliferation of MRBMs and LACMs. The technology is mature and available. Today, theater ballistic missiles that overmatch PAC-3 (still four years away from its IOC) are under development and in service in limited numbers. Defending against such threats requires a medium-range active defense system. Remember, as well, medium-range defense is also area defense. An adversary could use today's SRBMs to attack large population centers. PAC-3 and Navy Area Defense force structure would be inadequate for defending against such attacks. So, in addition to defeating the medium-range threat, THAAD will provide a bona fide area capability against today's predominant threat--the SRBM. Expanding this initial area defense capability should be a priority, as well. Here, ascent-phase and BPI capabilities have potential. In addition, as cruise missile defense technology becomes mature, resources should be made available for expeditious fielding of an initial LACM defense.

There may be a tendency to view tomorrow's threat as a lower priority threat. This is not necessarily the case. Time is not always linear or uniform as it relates to preparing for high-tech warfare. Developing, testing, and procuring missile defense systems takes time. Threat development can speed up, slow down, or stop, based on many factors. Publicly conducting an active defense program may, in fact, deter an adversary from pouring scarce resources into a theater missile program. So, to hedge against false assumptions, steady progress toward the full range of

capabilities should be supported. This view is consistent with many in the TMD community, as well as top-level planning guidance. The Services and BMDO have charted such a course. Supporting the current momentum provides the least-risk route to the objective--*providing joint force commanders the capabilities required when they are needed.*

Proceeding from that foundation, this study developed the following guidelines for its budget analysis:

- avoid delaying progress toward IOCs
- leverage established programs to the extent possible
- have contingency plans for unexpected threat developments
- be sensitive to the cost-per-unit increase triggered by reducing procurement

The budget analysis consisted of program adjustments aimed at lowering the composite funding profile below the $2 billion ceiling. Program estimates are those published by BMDO and, in the case of proposed systems, the Services.

The $2 Billion Per Year Ceiling:
Reducing Expenditures While Preserving Options

The following figures show funding options leading to fielding of required materiel solutions. As alluded to above, expeditiously developing all of these required materiel solutions would address the requirements discussed above, but the guidance is to impose a $2 billion per year cap. As Figure 3-1 indicates, the core programs could remain under the cap; however, capability shortfalls would exist: there would be no sea-based defense against medium-range theater ballistic missiles, no protection for maneuvering forces threatened by all theater missiles, and no funding for development of a boost-phase intercept capability.

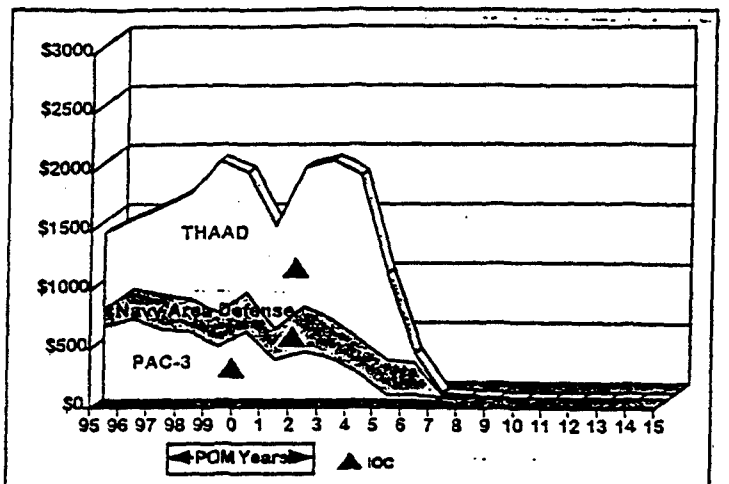


Figure 3-1: Core Programs

As portrayed in Figure 3-2, to acquire all active defense systems at the proposed procurement levels would exceed the funding guidance. PAC-3 and Navy Area Defense are fully funded, as well as two battalions of THAAD. In addition, near-term technology/demonstration funds for Navy Theater Wide are provided, preparing the way for a program initiation decision in FY 1998. The Army estimate of the U.S. portion of MEADS is also shown, as well as continued funding to support further boost-phase intercept technology development.

See Issue 9: Common Upper-Tier Interceptor page A-25

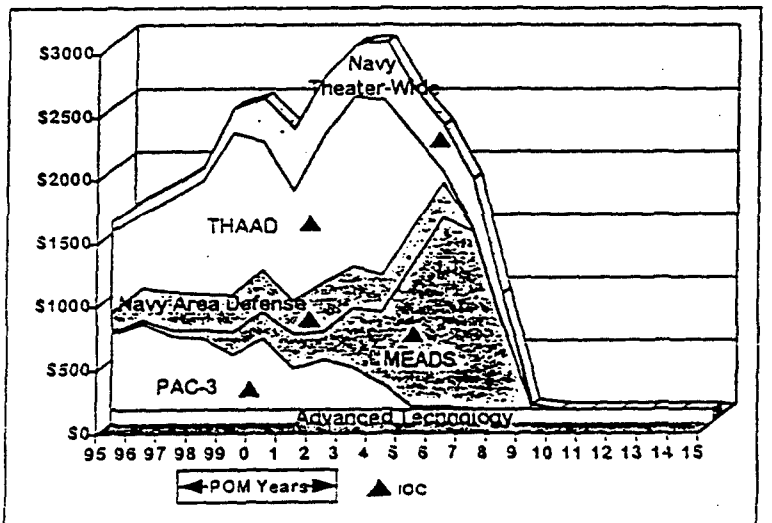


Figure 3-2: Funding for All Proposed Programs

Rather than accept capability shortfalls, this study proposes an approach which provides an *initial capability* to fill each requirement while providing core capabilities and staying under the $2 billion per year spending limit. The first measure in reducing costs was to examine deferral of force structure/missile procurement reductions.

Reduce PAC-3 Missile Procurement

Figure 3-3 reflects a reduction in PAC-3 missiles from 1200 to 600. As noted, there is no delay in initial operating capability. Although there is little near-term funding relief, out-year funds become available for buying additional PAC-3, MEADS, or an improved version of PAC-3, to be introduced later.

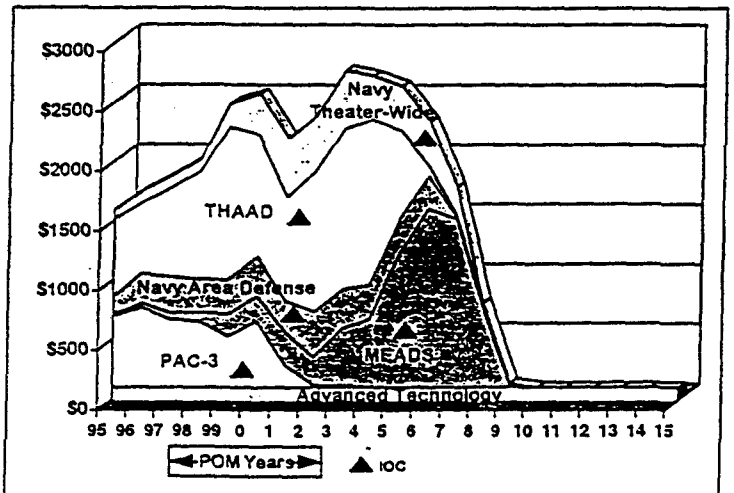


Figure 3-3: Reduction in PAC-3

Reduce THAAD Procurement

Figure 3-4 portrays a reduced THAAD procurement plan: one battalion. Although the price per unit increases, overall cost is reduced. The current THAAD IOC is unchanged. The $2 billion per year funding constraint, however, has yet to be met.

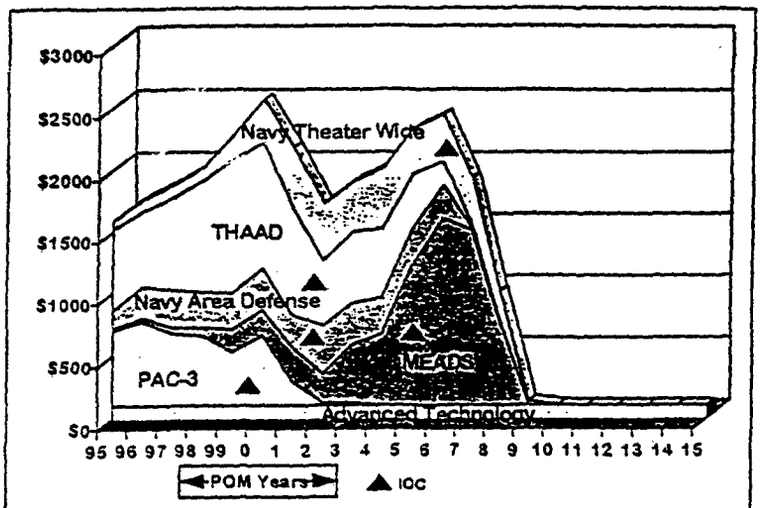


Figure 3-4: Reduction in THAAD

Apply U.S. Portion of MEADS Funding to PAC-4

See Issue 10: PAC-4 page A-27

Applying MEADS funding to develop a PAC-4 (instead of MEADS), redistributes out-year expenditures. The resulting PAC-4 system would be a tactically mobile ground-based active defense system. Certainly, this approach must be deconflicted with the MEADS program at an appropriate decision point. (While recognizing the political implications of this approach, the study finds that the funding constraint requires this type of decision.) A PAC-4 program could provide a contingency plan if the LACM threat develops faster than anticipated. Such an interim materiel solution seems to make sense. It would build on the successes of the Patriot program and, if capable of integrated operations with elevated sensors similar to those under consideration for ACTDs, could develop a UOES-type contingency option. In any case, funding a Corps SAM-like

gram as indicated in Figure 3-5 provides some relief in the r-term and contributes to a desirable funding projection in the years.

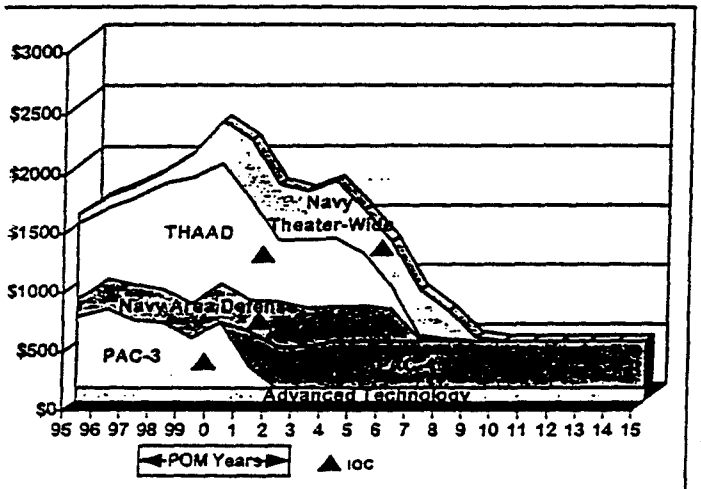


Figure 3-5: Develop PAC-4

ust Navy Theater Wide

final adjustment is to delay the program start of Navy Theater e. This measure preserves the overall procurement schedule e delaying the planned IOC one year (see Figure 3-6). This stment includes additional funding for technology lopment and accelerating procurement.

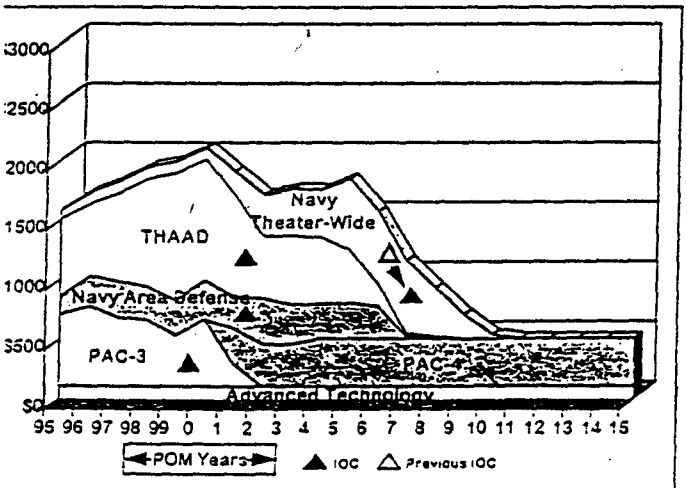


Figure 3-6: Adjust Navy Theater Wide

The program adjustments described above result in a funding profile meeting the guidance--not to exceed $2 billion per year -- while providing at least some portion of the required capabilities. These initial conditions establish a foundation for the integrated decision-point methodology which follows. They do so without increasing the current operational risk.

CHAPTER 4: IMPLEMENTING THE STRATEGY

Planned Acquisition Decision Points

Achieving the acquisition and fielding program discussed in Chapter 3 while maximizing force protection requires periodic decisions based on program successes and changing threat assessments. The study's methodology for reviewing requirements and assessing capabilities over time is based on the following guidelines:

- minimize operational risk
- leverage existing systems and technologies
- provide flexibility
- constrain cost (not to exceed $2 billion per year)

These guidelines can be followed by developing a strategy in which decision makers identify points along the system development process to reassess the threat, revalidate operational requirements, and review program and technology statuses. Decision points are designated at those optimal points in program development where sound decisions can be made on: performance-schedule trade-offs, procurement adjustments, and, if appropriate, program initiation/termination.

By identifying these optimal points in program development, decision makers can defer critical decisions on system trade-offs until threat and technological capabilities become more clear. Doing so avoids the unnecessary risk associated with making fielding decisions prematurely. This methodology can be implemented while staying within the mandated $2 billion per year.

The following series of decision points is intended as a composite program for synchronizing the three operational elements of a requirements-based acquisition strategy: system design criteria, force structure (procurement levels), and timing of fielding. These elements comprise the foundation of the requirements input. As the overall active defense systems user representative, the Joint Staff has a unique interest in this aspect of the acquisition decision process. At each step, these decisions should take into account the following input: the progress of all active defense systems development, the updated threat assessment, and the progress of command and control initiatives.

Certainly, this approach is not new; it reflects the existing acquisition and requirements framework. This synchronization plan does, however, support Joint Staff involvement in Integrated Product Teams, and the effort to provide the best possible acquisition strategy that can be implemented within the bounds of the funding guidance. This approach is consistent with the cost-as-an-independent-variable approach to trade-offs. The emphasis is on setting up performance-schedule trade-offs given funding guidance. Also driving this approach is the need to fund the complementary set of active defense systems through the Future Years Defense Program. So, the decision point methodology facilitates determining requirements within the overall acquisition effort.

THAAD

The central issue at the THAAD decision point (see Figure 4-1) is the scope and schedule for EMD.

THAAD

- Hit-to-kill Lethality
- Endo and Exo Engagements
- Robust Ground-Based Radar
- Significant Area Defense
- Defeats the Medium-Range Threat

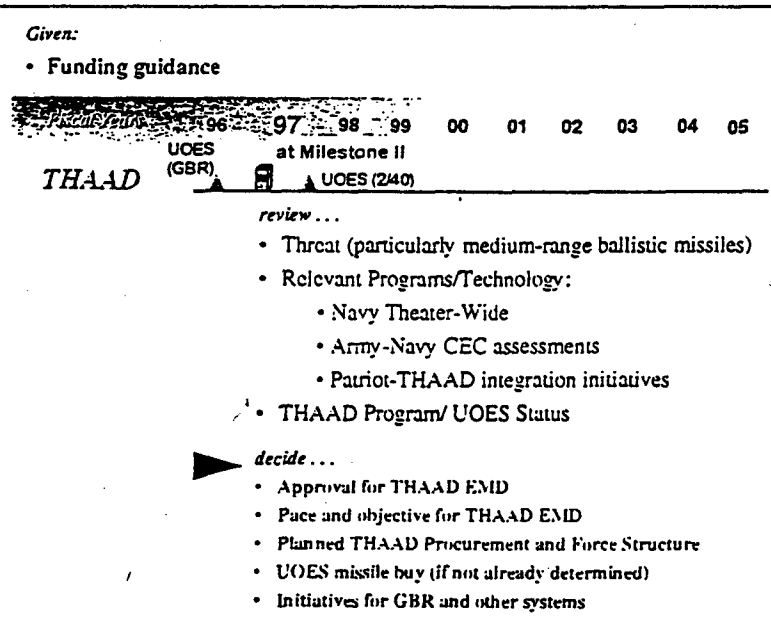


Figure 4-1: Integrated Decision Point (THAAD)

At this integrated decision point, consider these factors: current threat assessment (in particular, MRBMs); status of Navy Theater Wide technology development; Army-Navy Cooperative

Engagement Capability (CEC) assessments; status of Patriot-THAAD integration initiatives; and the status of the THAAD UOES battalion (activated at Fort Bliss, Texas, in 1995).

Specific decisions should include whether or not to approve THAAD for EMD, the pace to conduct EMD and the EMD design objective; whether or not to purchase UOES missiles and how many; and identifying initiatives for GBR applications to other systems.

PAC-3 Procurement

PAC-3

-to-kill Lethality
proved Footprint
reased Firepower
reased Sector Size
feats Most of Short-
nge Threat

The key issue at the PAC-3 integrated decision point, Milestone III, is how many missiles to procure (see Figure 4-2). This study recommends setting procurement at 600 missiles. The decision on the remaining 600 missiles can be deferred, pending assessments of the following factors: the threat (in particular, the LACM), status of Patriot-THAAD integration initiatives, status of Army-Navy CEC assessments, status of Mountain Top demonstrations, status of Patriot-Aegis integration initiatives, status of MEADS PD-V, and assessments of potential to develop PAC-3 into a PAC-4 program.

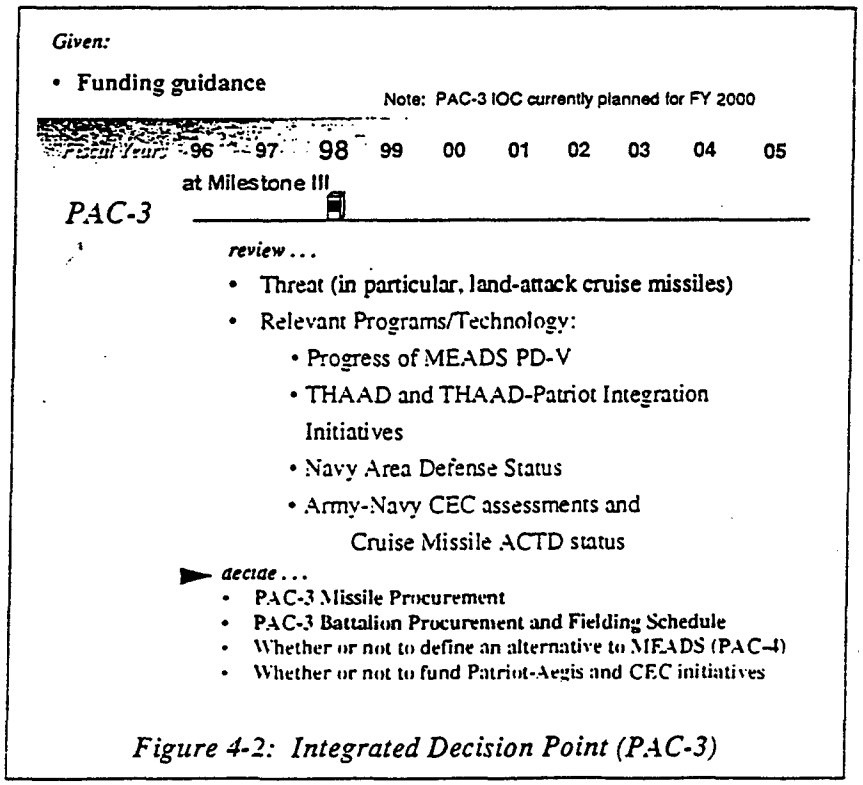


Figure 4-2: Integrated Decision Point (PAC-3)

At this decision point, determine the quantity of PAC-3 missiles to be procured, as well as the number of PAC-3-capable battalions to be fielded. In addition, decide whether or not to initiate program definition for PAC-4. Support for Patriot-Aegis integration initiatives should also be determined at this integrated decision point.

See Issue 11: CEC page A-29

Navy Area Defense Pre-Planned Product Improvement (P3I)

A Navy Area Defense integrated decision point should be scheduled to follow deployment of the Navy UOES in 1998 (see Figure 4-3). At this decision point, the plan for improvement of the Standard Missile-2 (SM-2) Block IVA warhead should be reviewed. Factors for consideration will be the proliferation of clustered submunitions, results of SM-2 Block IVA and PAC-3 lethality and flight tests, as well as PAC-3 Milestone III procurement decisions.

Navy Area Defense

- Forcible Entry Protection
- Forward Presence During Crisis Development
- Protects Assets in Littoral Regions
- Defeats Most of Short-Range Threat

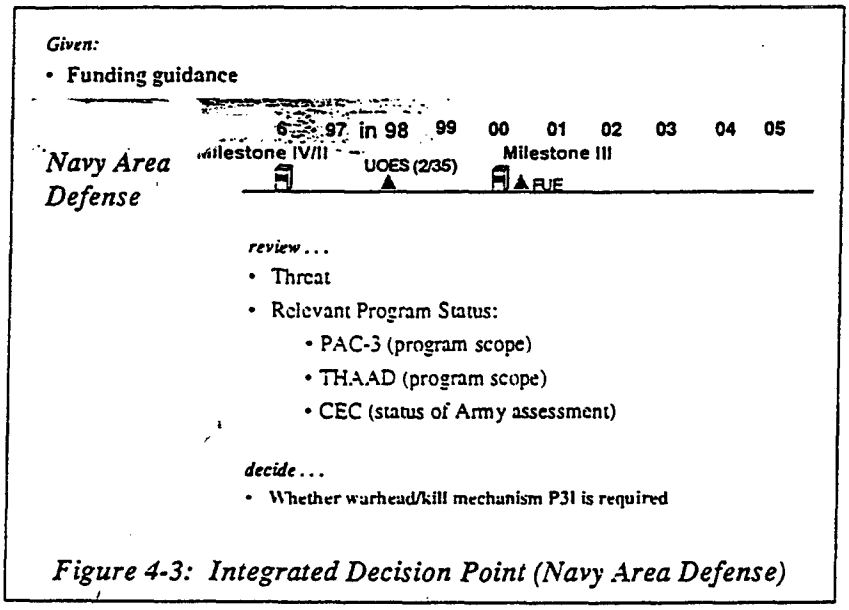


Figure 4-3: Integrated Decision Point (Navy Area Defense)

Navy Theater Wide Program Initiation

Navy Theater Wide

Ascent-Phase Capability
Forcible Entry Protection
Forward Presence During Crisis Development
Protects Assets from the Sea
Defeats Medium-Range TBM

A Navy Theater Wide decision point should be planned for 1998 (see Figure 4-4). The primary issue is whether or not to initiate a Navy Theater Wide program. If a program start is approved, the appropriate milestone for the new start would be determined. (Milestone IV/II modification to Navy Area Defense/SM-2 or another milestone.)

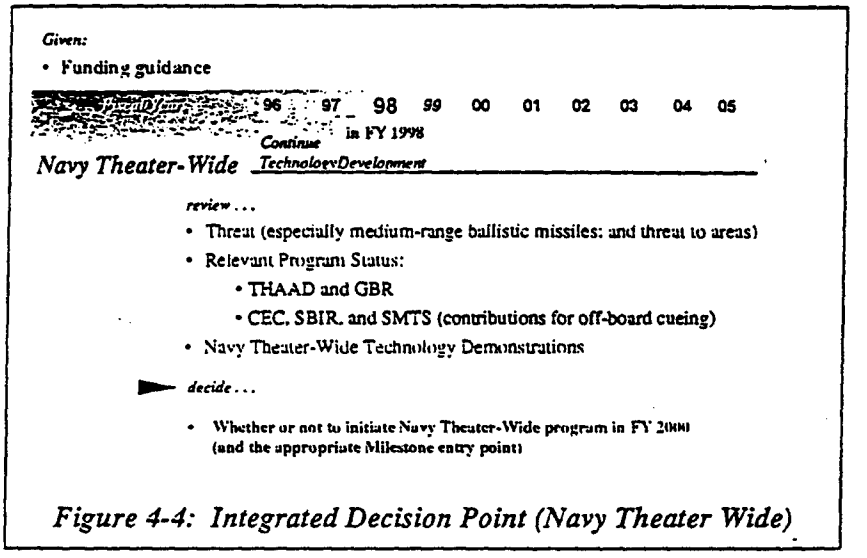


Figure 4-4: Integrated Decision Point (Navy Theater Wide)

See Issue 12: THAAD-NTW page A-31

Consider the following factors: MRBM proliferation and world-wide ballistic missile threat to areas, results of technology demonstrations, status of THAAD to include GBR, Army-Navy common missile assessments, status of CEC. Space-Based Infrared, and Space Missile Tracking Systems. Navy Theater Wide approval for new start would set up program initiation in FY 2000.

PAC-4 or MEADS

The conclusion of MEADS PD-V scheduled for 1999 is the appropriate time for determing whether or not to rely on MEADS to fill the tactically mobile, ground-based active defense shortfall. At this decision point, the extent of the U.S. funding commitment to MEADS should be assessed. If the program is on a schedule deemed adequate to meet the threat. the U.S. should provide sufficient funding to maintain the schedule to the projected IOC.

If not, another option such as PAC-4 must be funded (see Figure 4-5).

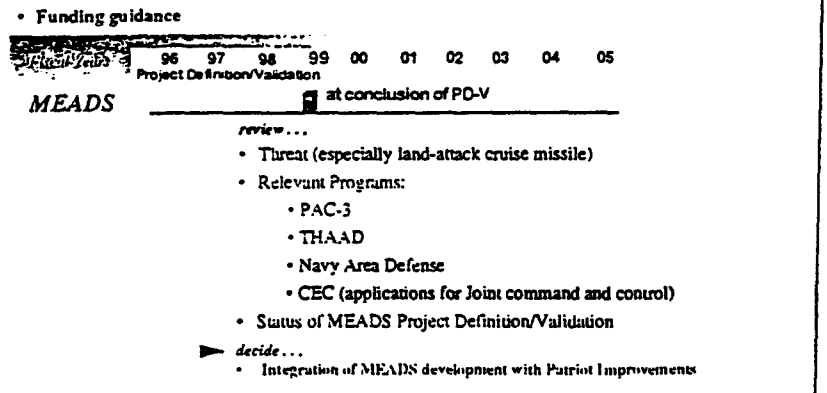


Figure 4-5: Integrated Decision Point (MEADS)

PAC-4 or MEADS

- Strategic Deployability
- Tactical Mobility
- Protection of Maneuvering Forces
- Defense Against Very Short-Range TBMs
- Area Cruise Missile Defense

Factors to consider include the urgency of the requirement for area cruise missile defense, the status of cruise missile defense ACTDs, and the cost effectiveness of developing a PAC-4 system.

Boost-Phase Intercept Assessments

At each integrated decision point, the advanced ballistic missile threat should be reassessed. This study did not define a BPI decision point, but views BPI technology assessment and selection as requiring continuing analysis.

Opportunities for Synergy

Identifying and exploiting opportunities to develop *operational synergy* has become a major effort in TMD development. Synergy, really an evolution and expansion of the principal of unity of command, is strongly endorsed within operational doctrine. Developing the *family of systems* to promote coordination, efficiency, and mutual support is receiving considerable emphasis. In addition, the search for ways to enhance capabilities through innovative combinations of existing or postulated weapons and sensors is a priority. Interestingly, the *Report of the Third U.S.-Allied TMD Workshop*, May 1994, notes

with respect to Army air defense/TMD that "synergy among systems--rather than redundancy in coverage--is emerging as the new byword among Army air defense and TMD planners" (Ref. 127). The same observation applies to all elements of joint TMD today.

The J-8 asked this study to comment on the TMD community's views on the more promising opportunities for developing operational synergy. The following initiatives have significant potential. Defining the expected pay-offs associated with these initiatives is receiving emphasis within the appropriate TMD organizations.

GBR is viewed as a powerful, robust radar, which may significantly enhance the efficiency of PAC-3 and Navy Area Defense. Its five-degree look angle will extend detection ranges and provide precision cueing for ballistic missile defense. GBR's capabilities may improve overall battle management as well. In addition, GBR's potential to improve launch point estimates could expedite and direct cueing of confirmatory sensors supporting attack operations. Improved impact point predictions could enable selective missile attack warning, thereby, reducing disruption of support operations caused by wide area missile attack alert requirements.

The primary benefit of a *terrestrialized Navy CEC* would be to provide extended, fire control quality cruise missile detection and tracking data to ships in the littoral. Additional benefits, however, include shared TBMD tracking data, especially valuable to land-based defenses adjacent to water and the Navy's Theater Wide system. Providing GBR data through a CEC-like net could extend the reach of sea-based TBMD, which has radar limitations over land areas.

Navy officials encouraged pursuing integration of Patriot and Navy TBMD sensor capabilities. This effort will require analysis of processor requirements to permit sharing of data.

Initiatives such as the Army *Force Projection Tactical Operations Center* and Air Force *Combat Integration Center* should be supported--with the best of the Service command, control, communications, computers, and intelligence solutions made available for tailoring by the CINCs. Until foolproof technical solutions to the pre-launch detection challenge are found, thorough, dedicated TMD intelligence analysis and operations personnel will be essential. It is their expertise in enemy tactics,

techniques, and procedures, and systems capabilities that narrows down the scope of the search process.

BMDO's Theater *Sensor Netting* Study indicates the improvements in cruise missile defense that can be achieved by providing an overlapping sensor network. These potential benefits include improved track continuity and combat identification, range extensions accrued through satellite relays, and regained low altitude battlespace through surveillance and fire control platforms.

The Joint Staff and BMDO proponents should continue to develop *TMD message sets* that will improve the clarity and availability of time-sensitive, theater-wide TMD data.

C3I Architecture & Battle Management/C3I: C3I may be the TMD element with the most urgent needs. The strategy described in the *BMDO Report to Congress* and supplemented by briefings provided by BMDO describes a comprehensive, intelligent approach for developing command and control synergy. Funding priorities noted in that strategy are promising. The *fiscal synergy* that would result from providing the Joint Staff significant funding for such initiatives should be considered.

Conclusion

Sequentially developing systems, while maintaining the momentum toward fielding a full array of initial operating capabilities makes sense: the approach is affordable and provides these advantages;

- allows an enemy *no free ride*
- promotes vigorous *pursuit of innovative technologies*
- positions the acquisition community to *shift the main effort* if necessary
- reflects attention to the likely appearance of *new threats*
- provides *a hedge against inaccurate threat predictions*
- provides reasonably *complementary capabilities*, which provide the CINCs tailorable packages that can thicken *defenses in depth* and provide mutually supporting defenses
- provides *continuity*--building on past successes and a body of solid active defense analysis

- *preserves options* regarding force structure, design criteria, and procurement quantities
- has a *deterrent* effect

Above all, mapping out the future of active defense systems acquisition presupposes commitment to missile defense. That commitment is solidly articulated in national policy. Accomplishing that difficult set of missions, however, requires a robust package of systems.

A funding ceiling of $2 billion per year for active defense systems represents 0.8% of the DoD budget (see Figure 4-6). Although the

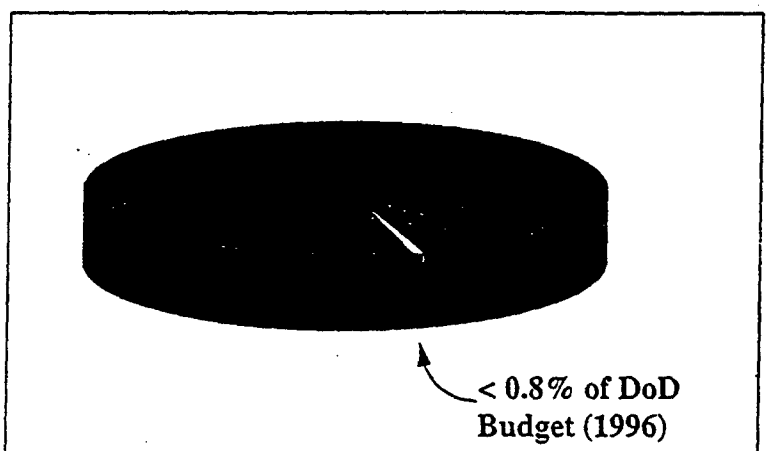


Figure 4-6: Active Defense Budget

package of capabilities above provides CINCs the wherewithal to deploy complementary and mutually supporting active defense systems, there are no redundancies, when one thinks in terms of *both space and time*. The Commission on Roles and Missions' call for *early* decisions on *competing* ideas should be carefully applied when considering the various threats grouped under the term *theater missiles*. If the national guidance continues to stress the need for force and population protection during dynamic force projection operations, the conditions are set to support that goal with an appropriate acquisition strategy.

That strategy, however, must provide adequate capabilities over time. On this topic, Rear Admiral (Ret.) Wayne E. Meyer, former director of the Aegis program, noted that air and missile defense is always a matter of *coping* with the threat. He advised guiding on

the ultimate solution, but realizing the *ultimate* array of systems will continue to recede into the future. In the meantime, battles will be fought, and they will be fought with so-called *interim* materiel solutions.[8]

Viewing the long-term missile defense campaign as a series of well-engineered interim solutions, employed within a well-coordinated joint command and control architecture, is prudent. That approach, reflected in this study, is the best way to provide the CINCs *what* they need *when* they need it.

NOTES

[1] The THAAD User Operational Evaluation System is projected to be available for national contingencies in FY 1997. The decision to purchase the THAAD UOES missiles was pending as of this report. In fact, the Army, responding to emerging guidance on theater missile defense funding, has been preparing THAAD program options.

[2] A note on United States Marine Corps Hawk: an improved Marine Corps Hawk system with short-range ballistic missile defense capability will be fielded, according to the *BMDO Report to Congress*, between FY 1997 and FY 2000. The Army has phased Hawk out of the active component inventory. In addition, the Commission on Roles and Missions stated: ". . . the Army's core competence in ground-based area air defense is duplicated, in part, in the Marine Corps. Once the command and control enhancements recommended above are in place, we recommend retiring the Marine Corps' Hawk missile units and giving the Army responsibility for ground-based area air defense for all land forces operating beyond the range of naval air and missile defense systems."

[3] The BMDO *1995 Report to Congress* notes that the *Comprehensive TMD Missions and Programs Analysis* includes four related studies: the *TMD COEA*, the *Technical and Engineering Commonality Analysis*, the *TMD Command and Control* [C2] *Plan*, and the *Threat and Missions Priorities Analysis.* A preliminary briefing on phase one of the *TMD COEA* was made available to this study.

[4] In this report, the designation *PAC-4* refers to a follow-on to the PAC-3 system. This improved Patriot would be an alternative to Corps SAM or MEADS. This proposed PAC-4 has not been endorsed by the Army, although high-level discussions related to PAC-4 developed some momentum in the latter half of 1995. PAC-4 would aim to enhance strategic deployability, tactical mobility, and active defense against very short-range ballistic missiles and cruise missiles. A PAC-4 could eventually operate a netted-distributed sensor and C2 system, enabling wide area cruise missile defense and remote-launch.

[5] Office of Technology Assessment. *The Effects of Nuclear War.* Washington, DC, 1979. Insert as reported by Dickey, C. "His Secret Weapon," *Newsweek*, September 4, 1995, 34.

[6] *The Army Cruise Missile White Paper* (final draft), issued by the Chief, Air and Missile Defense Division, Office of the Assistant Chief of Staff for Operations and Plans, Force Development, Headquarters, Department of the Army, November 9, 1995, discusses several aspects of the LACM evolution:

> There are a number of ways in which the rapid spread of CMs [cruise missiles] can happen. One is the sale or transfer of

> missiles, which is probably the fastest way for any country which wants to build a lethal arsenal quickly. According to the Defense Science Board Summer Study of 1994, Russia is currently trying to sell LACMs and France has expressed its intent to sell its Apache cruise missile. The U.S., Italy, Israel, and Germany are also potential CM merchants. Weapon sales can leak past the intended customers into the hands of adversaries. Russia and several of the former Soviet Union States have large arsenals of weapons, including LACMs. As they continue to struggle economically, the temptation to sell weapons to other countries will grow stronger. . A second pathway for proliferation is the conversion of UAVs [unmanned aerial vehicles] and anti-ship missiles to a land-attack role. The U.S. converted the Harpoon ASCM into the Standoff Land-attack Missile (SLAM) in approximately 18 months. A developing nation could conceivably accomplish this task in 2-3 years. A third method is to use reverse engineering. China's CM program probably grew from its acquisition of the Russian SS-N-2 Styx, and its C-801 and C-802 are reverse engineered from the Exocet. Fourth, countries capable of building ballistic missiles, submarines, sophisticated aircraft, or space launch vehicles could refocus their industries to build cruise missiles. Finally, lesser developed countries, given an appropriate level of national priority, could buy commercial-off-the-shelf (COTS) technologies and assemble their own LACMs. The component technologies are readily available on the commercial market. Fifteen years ago, a five-channel GPS [Global Positioning System] receiver cost around $100,000. Today they are available on the commercial market for under $400. Twenty-channel receivers are available, commercially, for $2,000 to $4,000 each.

[7] Centre for Defence and International Security Studies. Bailrigg Memorandum 7. *Timely Defence Against Missiles: Lessons From British Experiences With Air and Missile Defence*, 1994, 12.

[8] Interview with Rear Admiral Wayne E. Meyer, (USN, Ret.), at Arlington, Virginia, 17 October 1995.

APPENDIX A: ISSUES

Introduction

The following discussions frame key issues in the integrated acquisition process. Not designed to take a position or resolve the issue, each paper is offered as a prompt for further research. References cited in the margins are annotated numerically as they appear in the Annotated Bibliography, Appendix E.

The positions described generally represent the two extremes of the rhetorical spectrum, rather than a comprehensive list of all positions.

REFERENCES

- Letter from Chairman, JCS, GEN Shalikashvili, to Senator Strom Thurmond, 5 Jul 95 (Ref. 86)
- *Navy Theater Ballistic Missile Defense ORD* (U), Draft F, 7 Nov 95 SECRET (Ref. 107)
- *Navy Theater Ballistic Missile Defense Overview* briefing, RADM Rempt, OPNAV (N865), 29 Sep 95 (Ref. 39)
- *ORD, Patriot Advanced Capability, Phase Three (PAC-3* (U)), 1 May 92, revised 8 Dec 93 SECRET (Ref. 94)
- Naval Surface Warfare Center Dahlgren Division, technical discussions, 2 Nov 95
- Navy Area TBMD Acquisition Decision memorandum, 24 Aug 94 (Ref. 85)
- *USSPACECOM Capstone ORD for BMD* (U), 9 Dec 94 SECRET (Ref. 98)
- *TMD COEA Phase I Report* (U), 21 Nov 95 SECRET (Ref. 62)
- *Report to Congress on BMD, 1995*, Sep 95 (Ref. 137)

Issue 1: Are lethality standards adequately defined?

Background

Today, theater missiles can deliver unitary warheads containing conventional high explosives (HE) or weapons of mass destruction (WMD). The development and proliferation of clustered submunitions is less well defined. In the future, one trend in warhead development is likely to include the early release of submunitions. This array of potential warhead and terminal delivery options has made measuring lethality or warhead negation a prominent issue--especially among the Services. (*Lethality* generally applies to measuring the effectiveness of the destruction of a theater missile (TM) warhead before its effects can be brought to bear against friendly ground forces, key assets, or host nation/coalition population centers and territories.) The Army advocates hit-to-kill intercepts, while Navy Area Defense will employ a fused fragmentation warhead and Navy Theater Wide seems likely to employ a Lightweight Exoatmospheric Projectile (LEAP) (kinetic intercept). Air Force briefings, in particular, as well as the *Theater Missile Defense (TMD) Cost and Operational Effectiveness Analysis (COEA) Phase I Report*, have emphasized the unique capability of boost-phase intercept to negate early release submunition-equipped ballistic missiles, which generally engage a theater ballistic missile (TBM), rather than the warhead. The *TMD COEA Phase I Report* noted that boost-phase intercept (BPI) is the only active defense option against early releasing submunitions.

The *United States Space Command (USSPACECOM) Capstone Operational Requirements Document (ORD) for Ballistic Missile Defense (BMD)* establishes negation probability values for critical asset and area defense. The *Capstone ORD* defines negation as "RV [reentry vehicle] destruction per expected value or other actions which prevent damage to the defended area from conventional, nuclear, chemical, or biological effects." Negation probability values were established to characterize the level of protection based upon operational judgment.

While acknowledging the need for terminal defenses to negate the warhead and missile debris completely, some Navy officials emphasize that engagement in other phases of the trajectory may provide options that do not require the same degree of lethality.

Position 1

The fused fragmentation warhead lethality of some Standard Missile-2 (SM-2) Block IVA will be more robust than predicted by models and simulations. On Navy Theater Wide, the high velocity of the enhanced SM-2 Block IV, given the other parameters of intercept at high altitudes, will generate sufficient kinetic energy to achieve an acceptable level of lethality.

Position 2

The Navy's fragmentation warhead for its SM-2 Block IVA missile (endoatmospheric or lower-tier) will be insufficiently lethal, especially with respect to destruction of submunitions. Additionally, the proposed LEAP kill vehicle for the Navy Theater Wide system (exoatmospheric or upper-tier) will be unable to generate sufficient momentum to negate warhead effects.

Discussion

Chairman, Joint Chiefs of Staff, General Shalikashvili, in a letter to Congress, 5 July 1995, said that the Navy's SM-2 Block IVA or lower-tier missile provides adequate capability against TBM with unitary warheads and "scheduled preplanned product improvements are expected to significantly increase the capability against the chemical submunition threat." The *Ballistic Missile Defense Organization 1995 Report to Congress on Ballistic Missile Defense* states:

> Future efforts will focus on improving the guidance of the Block IVA to effect increased lethality against emerging threats including chemical submunitions and other weapons of mass destruction. The August 1994 Defense Acquisition Board review of Navy TBMD [Theater Ballistic Missile Defense] endorsed this evolutionary approach and approved risk reduction activities leading to a Milestone IV Defense Acquisition Board in FY 1996.

There are existing standards for lethality or the damage required to "kill" manned aircraft; however, the standards to measure a "kill" against ballistic missiles are less easily defined and a subject of discussion among the Services and the Office of the Secretary of Defense (OSD). Lethality against TBMs carrying WMD, early release of submunitions, and fractionating warheads needs special

considerations as compared to lethality against conventional unitary HE warheads. Unitary HE warheads may sympathetically detonate from kinetic energy transfer on impact of the interceptor kill vehicle, rendering them ineffective.

The following TBM specific considerations are important for understanding and evaluating lethality measures of effectiveness for TBM intercepts. The principles of ballistic motion, trajectory dynamics, conservation of motion energy, and effects of the atmosphere on flying objects must apply. These factors cause the lethality for lower-tier and upper-tier systems, as well as terminal and ascent-phase intercepts to differ. Debris resulting from descent-phase engagements or intercepts may impact the ground at or near the designated target. Thus, lower-tier defense systems, especially, might be expected to engage with a higher degree of endgame lethality.

Upper-tier, ascent-phase, or boost-phase systems may be able to negate warhead effects--and protect the defended area or asset--through less lethal engagement mechanisms or processes. "Mission kills" similar to those that can characterize defense against aircraft may be acceptable. Disabling a warhead fuze, deflecting a TBM off target, or other engagement processes are possible. The degree of trajectory deviation achievable against any TBM varies with the trajectory (lofted, depressed, maximum range, etc.) and the defense scenario. Also, the amount of deviation or deflection will vary depending on the timing of the engagement. Nonlethal engagement of TBMs after boost-phase may cause negligible deviation because the warhead re-entry vehicle will be traveling at burnout velocity and no longer be subject to the ascent atmospheric conditions. On the other hand, chemical and biological warheads that are ripped open in the higher altitude in the exoatmospheric vacuum will be diffused over a wide area and rendered militarily ineffective.

Boost-phase intercepts appear to provide the earliest opportunity to defeat a threat missile by intercepting it early in flight -- before it achieves its ballistic trajectory characteristics. However, the question remains as to whether the boost-phase technologies negate the effects of warheads and falling debris sufficiently so that forces and assets on the ground are no longer endangered. Boost-phase intercepts could terminate thrust or modify the thrust vector direction of the booster early enough during boost phase to negate warhead effects on protected assets. If intercepted before booster burnout, TBM shortfall or trajectory alteration may cause WMD effects to fall onto the aggressors' territory. Engagements

after booster burnout, however, may risk the warhead effects still reaching the protected assets or other targets of importance.
The magnitude of a warhead's effects on the ground differ, depending on whether the protected personnel are military in a protective posture or civilians, possibly untrained and unequipped for dealing with direct or residual WMD effects. Active defense lethality requirements could take into account passive defense measures, but active defense of populations, instead of troops, will obviously necessitate more stringent lethality requirements for TMD systems. Because development of variable lethality mechanisms on a single system is likely to be impractical, firing doctrine and fire unit/ship positioning could be adjusted if military risk must be factored into priorities. To ensure terminal defense warhead negation, however, a robust intercept or engagement mechanism seems advisable and supported within the Joint Staff, OSD, and the Services.

Point(s) to be Resolved

All Services are confident that their technical solutions will deliver the required capabilities. In preparation for each system decision point, the Joint Requirements Oversight Committee should invite Service comments on proposed key performance parameters related to the broad term *lethality*, as well as integrated system or systems effectiveness. The complementary nature of missile defense operations--in particular the need for inter-Service operations--makes this issue appropriate for the joint user to coordinate.

REFERENCES

- Schomisch, J. W., *1994/95 Guide to Theater Missile Defense*, Pasha Publications, Arlington, VA, 1994 (Ref. 117)
- *BMDO TBMD Capstone STAR* (U), 30 Apr 95, SECRET (Ref. 145)
- Navias, Martin, *Going Ballistic: The Build-Up of Missiles in the Middle East*, Brassey's, Great Britain, 1993 (Ref. 116)
- Greenwald, Bryon E., *Scud Alert! The History, Development and Military Significance of Ballistic Missiles on Tactical Operations*, The Land Warfare Papers, No. 22, Oct 95 (Ref. 112)
- DIA briefing, "*The Ballistic Missile Threat Summary*" (U),8 Sep 95, SECRET (Ref. 146)
- Bailrigg Memorandum 9, *Ballistic Missiles -- The Approaching Threat*, published by CDISS, 1994 (Ref. 108)
- DoD, *Report of the 1994 Defense Science Board Summer Study Task Force on Cruise Missile Defense*, Jan 95 (Ref. 129)

Issue 2: How urgent is the requirement for active defense against the medium-range ballistic missile threat?

Background

According to J. W. Schomisch, in his *1994/95 Guide to Theater Missile Defense*, ballistic missiles have proliferated to 33 countries. The *Ballistic Missile Defense Organization Capstone System Threat Assessment Report* supports this finding. Although they have ranges from 40 to 3,000 kilometers (km), nearly all of them are below 650 km with most under 350 km. The popularity of short-range ballistic missiles has prompted the development of a theater missile defense (TMD) to provide protection from them. Next, comes the question, "***How urgent is the need for a TMD against the medium-range ballistic missile (MRBM) threat?***"

Position 1

Development of MRBMs in Third World countries has become bogged down in technology and fiscal problems, so the threat does not present a near-term need for active defense.

Position 2

Several countries already have MRBMs in limited quantities. Technology problems can be circumvented by purchasing MRBMs on the open market and black market. Technology problems can also be circumvented by using commercially available space launch components for MRBMs. Consequently, there is a near-term need for active defense.

Discussion

Aaron Karp, a United Nations consultant, reports that Third World ballistic missile programs are experiencing a slowdown. Janne Nolan, of Brookings University, agrees that they are bogged down in rather serious technical problems. She goes on to say that the chief problem is in developing or acquiring guidance systems. Martin Navias explains in his book, *Going Ballistic: The Build-up of Missiles in the Middle East*, that guidance systems for cruise missiles (CMs) can be fashioned out of inertial navigation systems aided by the Global Positioning System. At the subsonic speeds of CMs, this results in circular error probables of less than 100 meters. The guidance problem for ballistic missiles, however, is much more complex. The complexity is caused by the supersonic

speeds of the ballistic missiles. At the higher velocities, high speed processors are needed to compute guidance corrections in a timely fashion. The processors also have to be ruggedized to withstand the shock, vibration, and heat of a high-speed ballistic missile. Conversely, as Schomisch explains, Rian Chow, of RAND Corporation, writes that ballistic missile technology is so comparable to space launch technology that Third World countries will be able to skirt around the development issues by purchasing the components they need on the open market.

The programs are also having problems developing re-entry vehicles and the ablative materials to provide them re-entry thermal protection. On the other hand, Schomisch states that Patricia McFate and Sidney Graybeal, of SAIC, argue that a re-entry vehicle heat shield does not have to be very sophisticated, and no one challenges the ability of Third World nations to provide heat shields capable of protecting nuclear weapons.

Schomisch further reports that Peter Zimmerman, Center for Strategic and International Studies, argues that propulsion systems are also bogged down in development. Going to longer ranges now requires a design change. Bryon Greenwald states, in his *Scud Alert!* paper, that most short-range ballistic missiles are variants of the Scud. The Defense Intelligence Agency threat briefing of August 1995 agrees and states that Scud technology has been pushed to the limit. Missile designs have a number of parameters that have limits beyond which inflight stability is lost. Three such examples are length to diameter ratios, structural rigidity, and mass flow rate caused by fuel consumption. Consequently, to get into the MRBM spectrum of ranges, a new propulsion design is needed. Again, McFate and Graybeal argue that propulsion problems can be solved by turning to the space launch industry.

Bailrigg Memorandum 9 shows that China, Israel, and Saudi Arabia already have MRBMs in service. It also shows that Belarus, China, France, Israel, Kazakhstan, Russia, Ukraine, the United Kingdom, and the United States have much longer range ballistic missile systems currently in service. Furthermore, India, North Korea, and South Africa have ongoing development programs for MRBMs. Finally, India and Japan have space launch vehicles that exceed the ranges of MRBMs.

Point(s) to be Resolved

All of this information tends to show that the urgency of the MRBM threat is far from fully characterized. Consequently, the urgency of need for an active defense system to protect against them is also inadequately characterized. The *Defense Science Board 1994 Summer Study on Cruise Missile Defense* suggested that the intelligence community take a proactive approach to anticipate the cruise missile threat instead of simply confirming it. A similar approach may be required for MRBMs. Since the upper-tier systems will provide active defense against MRBMs, a resolution of the issue would be appropriate prior to making procurement decisions for these systems. The first of these will be the integrated decision point at Theater High Altitude Area Defense Milestone II.

Issue 3: How urgent is the early release of submunitions threat?

REFERENCES

- *BMDO TBMD Capstone STAR* (U), 30 Apr 95, SECRET (Ref. 145)
- U.S. Air Force Scientific Advisory Board report, *Data Validation for the BMDO TMD COEA*, 4 Apr 95 (Ref. 132)

Background

As the United States produces systems that have theater missile defense (TMD) capabilities, adversarial nations will implement reactive threat measures. Department of Defense Instruction 5000.2M, subject: *Defense Acquisition Management Policies and Procedures*, dated 23 February 1991, defines reactive threats as those changes that might reasonably be expected to occur in threat doctrine, strategy, tactics, force levels, technology, and weapon systems as a result of the fielding of a new capability such as theater missile defense. A reactive threat that can be anticipated in response to TMD systems is the use of early release of submunitions. Therefore, it is prudent to investigate the urgency of this threat.

Position 1

Ballistic missiles may carry nuclear, biological, or chemical weapons or submunitions. The threat of the early release of submunitions is very real.

Position 2

The early release of submunitions may involve such inaccuracies that passive defense measures are adequate to prevent them from becoming a significant threat.

Discussion

See Classified Supplement (Secret/WNINTEL) to *A Theater Missile Defense Integration Study* for discussion of this issue.

REFERENCES

- Joint Publication 3-01.5, *Doctrine for Joint Theater Missile Defense*, 30 Mar 94 (Ref. 74)
- NATO Senior Defense Group on Proliferation, Active Defense Sub-Group, Final Report (U), 29 Sep 95 SECRET (Ref. 136)
- *USSPACECOM Capstone ORD for BMD* (U), 9 Dec 94 SECRET (Ref. 98)
- *Navy TBMD ORD*, Draft F, 7 Nov 95 SECRET (Ref. 107)
- *Joint Theater Missile Defense Concept of Operations*, JCS (J-36), 17 Feb 95 (Ref. 73)
- Overview and Summary of Preliminary Findings for TMD Capstone COEA (U), 11 Sep 95 SECRET (Ref. 61)
- *Army Theater Missile Defense (TMD) Strategy* briefing, 14 Sep 95 (Ref. 32)
- *Upper/Lower-Tier TBMD Systems Sensitivity Analysis*. (U), Jun 95 SECRET (Ref. 17)
- *TBMD Capstone STAR* (U), 30 Apr 95 SECRET (Ref. 145)

Issue 4: Does the Joint Theater Missile Defense mission require a multi-tier active defense?

Background

Joint Publication 3-01.5, *Doctrine for Joint Theater Missile Defense*, 30 March 1994, states, "the role of active defense operations is to protect selected assets and forces from attack by destroying TM [theater missile] airborne launch platforms and/or TMs in flight." It further states that defense in depth provides multiple opportunities to negate the TMs with differing capabilities, increases probability of kill, and prohibits the enemy from being able to counter the defensive system with a single technique.

The essential ingredients for defense in depth are the capability to detect, track, identify, intercept, and destroy TMs in flight. Planned acquisitions that will provide defense in depth include seven systems that operate in multiple tiers or multiple phases of a trajectory. These are lower-tier and upper-tier, as well as boost and ascent-phase engagement regimes. Out of this multiplicity of systems and tiers rises an issue of how many systems and tiers are really needed to provide an adequate defense.

Position 1

The *United States Space Command (USSPACECOM) Capstone Operational Requirements Document (ORD) for Ballistic Missile Defense (BMD)*, December 1994, advocates a balanced multi-tier package of capabilities providing "defense in depth" is required to defend against theater ballistic missiles. It goes on to say the theater ballistic missile defense (TBMD) system must consist of at least two tiers, which may each have multiple individual TBMD systems for defense in depth.

Position 2

There should be no requirement for multiple tiers of TBMD nor can the United States afford multiple systems. We should invest in one primary TBMD system which can operate both "endo" and exoatmospheric.

Discussion

Lower-tier systems have been a necessity since air power was introduced in World War I. So the foundation for any TBMD is

the existing lower-tier. These systems were originally designed to defend against air breathing threats and have, in recent years, been enhanced to protect against short-range ballistic missiles (SRBMs). This is a natural process because no matter where you want to go, "*You have to start from where you are!*"

The *TBMD Capstone System Threat Assessment Report* categorizes ballistic missiles as follows:

- Very short range: ranges of < 80 km
- Short-range ballistic missiles: 80 - 1,000 km
- Medium-range ballistic missiles: 1,001 to 3,000 km

Current lower-tier systems that are at various stages of development include Patriot Advanced Capability-3 (PAC-3), Navy Area Defense, and Medium Extended Air Defense Systems. The ballistic missiles against which these systems provide protection are the SRBMs. They are terminal defense systems in that they intercept ballistic missiles in the latter stages of their trajectories. They are also called "endo" systems because they operate inside the earth's atmosphere. They are effective up to altitudes of around 20 to 30 kms. They are not effective as "exo" systems--outside the atmosphere. They also are not as effective against medium-range ballistic missiles (MRBMs). The closing velocities of the MRBMs may exceed the maneuver capabilities of the lower-tier systems.

Effective protection from MRBMs must come from new systems. These new systems are the Army's Theater High Altitude Area Defense (THAAD) and Navy Theater Wide systems. These systems are considered upper-tier systems. They are capable of defending against the MRBMs. THAAD is both an "endo" and "exo" system. Navy Theater Wide is an "exo" only system. According to the Air Force Scientific Advisory Board, the airborne laser (ABL) and airborne interceptor (ABI) are boost-phase systems. The ABL is intended to defeat ballistic missiles at altitudes of 11 to 40 km while still in the boost phase, which implies that it could defend against both SRBMs and MRBMs. The ABI is intended to defeat ballistic missiles at altitudes of 40 to 70 km, preferably still in the boost phase. Hence, the ABI defends in the exoatmosphere. The ABL and ABI offer the earliest opportunity to intercept a threat missile. Navy Theater Wide offers the next opportunity for engagement while the missile is still in the ascent phase. THAAD begins offering engagement

opportunities in midcourse and the lower-tier systems offer the last opportunities which are in the terminal phase.

As mentioned above, multiple shots facilitate the maximization of the probability of successfully killing an incoming threat missile. In order to meet the *USSPACECOM Capstone ORD for BMD* requirements for protection, four shots are needed by most of the systems. The lower-tier systems are working in too small a time window to shoot-look-shoot four times. A multitude of systems may be needed for that firing strategy to ever be realized. However, the simultaneous development and acquisition of all seven proposed systems far exceeds budget capabilities. Furthermore, such a dramatic action as that, may not be warranted by the anticipated evolution of threat. So, the thought of fielding a fewer number of systems that will adequately handle all theater missile defense missions over land and water alike may have merit.

Point(s) to be Resolved

Reduction in the number of systems and number of tiers requires the resolution of several of points. First, what are the advantages of having common systems for land and sea-based versions which protect against similar elements of the threat? This question is addressed in more detail in Issue #9. Next, should separate systems that treat common elements of the threat have standard requirements? The lethality requirement is addressed in Issue #1. Furthermore, what are the practicality and effectiveness of airborne active defense systems? This question is treated to some degree in Issue #7.

All of these points need resolution from an integrated/joint perspective before major acquisition decisions are to be made for the systems under development. In Fiscal Year (FY) 1997 decisions are planned for Navy Theater Wide and THAAD. In FY 1998 a Milestone III decision will be needed on PAC-3. All of these points should be settled in time to be contributors to these decisions.

Issue 5: Should the Ballistic Missile Defense Organization Charter explicitly include cruise missile defense?

Background

Department of Defense Directive 5134.9, subject: *Ballistic Missile Defense Organization [BMDO]*, dated 14 June 1994, is the organizational charter. The mission stated therein specifies a requirement to "Enable deployment of an effective and rapidly relocatable advanced theater missile defense capability . . .". Joint Publication 3-01.5, *Doctrine for Joint Theater Missile Defense [TMD]*; the *Theater Missile Defense Mission Need Statement*; and the J-36, *Joint Theater Missile Defense Concept of Operations* define a theater missile (TM) as "ballistic missiles, cruise missiles (CMs), and air-to-surface guided missiles whose target is within a theater or which is capable of attacking targets in a theater." All of this could easily be interpreted to mean that the BMDO charter includes cruise missile defense (CMD). However, the *1995 Report to the Congress on Ballistic Missile Defense*, dated September 1995, states that BMDO has previously concentrated on the ballistic missile threat while the Services continued to develop counters to the other theater missiles. So the question arises: ***"Should the BMDO charter explicitly include the CM threat?"***

Position 1

BMDO is not funded or staffed to manage the development of CMD systems; therefore, BMDO should continue to concentrate on the ballistic missile threat. The Services should continue to be responsible for developing and acquiring systems to counter the threat of CMs.

Position 2

CMs are an integral part of theater missile threat. TMD lower-tier systems must be capable of defeating short-range ballistic missiles, CMs, and manned aircraft. Emerging Battle Management, Command, Control, Communications, Computers, and Intelligence systems must integrate system capabilities against all TM threats. As the Acquisition Executive for TMD systems, BMDO should be responsible for CMD development.

REFERENCES

- DoD Directive No. 5134.9, subject: *Ballistic Missile Defense Organization (BMDO)*, 14 Jun 94 (Ref. 118)
- Joint Publication 3-01.5, *Doctrine for Joint Theater Missile Defense*, 30 Mar 94 (Ref. 74)
- *Theater Missile Defense Mission Need Statement*, JROCM-064-91, 18 Nov 91 Ref. 87)
- J-36, *Joint Theater Missile Defense CONOPS*, 17 Feb 95 (Ref. 73)
- BMDO *1995 Report to the Congress on Ballistic Missile Defense*, Sep 95 (Ref. 137)
- *BMDO TBMD Capstone STAR* (U), 30 Apr 95, SECRET (Ref. 145)
- Schomisch, J. W., *1994/95 Guide to Theater Missile Defense*, Pasha Publications, Arlington, VA, 1994 (Ref. 117)

Discussion

The acquisition and development that BMDO is involved in, may not be completely separable from the CM threat. BMDO is chartered to acquire TMD systems, but only funded for theater ballistic missile defense (TBMD) systems. These include both upper-tier and lower-tier systems. The upper-tier systems, Theater High Altitude Area Defense and Navy Theater Wide, are specialized systems, defending only against ballistic missiles that exhibit specific trajectory and altitude characteristics.

On the other hand, the lower-tier systems; Patriot Advanced Capability-3 (PAC-3), Navy Area Defense, and the Medium Extended Air Defense System (MEADS), are all multi-purpose systems. Their requirements and capabilities include defense against not only ballistic missiles, but CMs and manned aircraft as well. None of the proposed systems or advanced technologies for TMD are planned as a ***"CM only"*** active defense system. BMDO is the agency responsible for the acquisition of PAC-3, Navy Area Defense, and MEADS. Furthermore, PAC-3, Navy Area Defense, and MEADS will most likely be required to complement each other on the battlefield and share tracking information. In this eventuality, integration during the acquisition process makes a great deal of sense.

The *BMDO TBMD Capstone System Threat Assessment Report* indicates that the CM threat may appear before the medium-range ballistic missile (MRBM) threat because CMs are less expensive and the technologies are much simpler. Most proliferation experts agree that CMs are a cheaper and easier way to build a TM inventory. The guidance problems associated with earlier land-attack cruise missiles (LACMs) can now be met by inertial navigation systems aided by the Global Positioning System or the Global Navigation Satellite System which are commercial technologies readily available on the open market. Additionally, the propulsion systems, or even some entire missile systems, are commercially available and the airframes are easy to build. According to the *1994/95 Guide to Theater Missile Defense*, Gary Milhollin, Wisconsin Project on Nuclear Arms Control, states that countries desiring to build or expand a missile inventory are going to choose the means which is most reliable, the easiest to acquire, and the cheapest. For the next five to ten years, that is going to be CMs. Consequently, LACMs are an imminent threat.

Point(s) to be Resolved

This issue needs to be resolved before the arrival of militarily significant numbers of LACMs on the battlefield. Also, it needs to be settled so that appropriate decisions for missile procurement can be made on those lower-tier systems that will counter the cruise missile threat. They are PAC-3, Navy Area Defense, and MEADS. The first decision for missile buy is the PAC-3 decision in Fiscal Year 1998.

REFERENCES

- *BMDO/Theater Missile Defense Bottom-Up Review*, 23 Aug 95 (Ref. 25)
- Joint Publication 3-01.5, *Doctrine for Joint Theater Missile Defense*, 30 Mar 94 (Ref. 74)
- JCS (J-8), Draft Final Report on *Threat and Mission Priorities* (U), 1995 SECRET (Ref. 144)
- MIT Lincoln Labs, *Attack Operations Study* (A Quick-Reaction Study for OSD and BMDO) (U). 5 Oct 95 SECRET (Ref. 138)
- SSDC, *Past and On-Going Attack Operations Analysis* (Compendium of material from the FAADS and AORS, the TMD Integration Study, and Attack Operations Analysis for the TMD COEA). Oct 95 (Ref. 53)
- JCS (J-8, JWAD), *Joint Warfighting Capability Assessment - TMD Attack Ops* (U), 1995 SECRET (Ref. 52)

Issue 6: Should materiel development of active defense systems consider tradeoffs between attack operations and active defense?

Background

Active defense has long been considered the indispensable element of theater missile defense (TMD). However, the *Ballistic Missile Defense Organization TMD Bottom Up Review* briefing of 23 August 1995 raised the suggestion that there may be tradeoffs between attack operations and active defense. Attack operations is an excellent idea because you are shooting the archer instead of the arrow. Joint Publication (JP) 3-01.5 states: "The preferred method of countering enemy TM [theater missile] operations is to attack and destroy or disrupt TM operations prior to their launch."

Position 1

It is hypothesized that improving attack operations could reduce requirements for active defense.

Position 2

Attack operations are an important aspect of TMD but cannot eliminate the potential of a threat missile attack. Once a TM is launched, an active defense system must destroy the incoming missile if it threatens a protected area or asset. Therefore, attack operations cannot be relied upon to significantly reduce the requirement for active defense.

Discussion

It could be said that attack operations and active defense are discrete tactical events. The Joint Chiefs of Staff (J-8) report on *Threat and Mission Priorities* lists nonproliferation measures, deterrence, attack operations, active defense, and passive defense as complementary components of the overall strategy of defeating the TM threat. Attrition of threat missiles will reduce the active defense missile inventory required, but will not erase the need for active defense. With all of this in mind, the more appropriate question may be "***How much can we reasonably rely on attack operations to reduce the burden on active defense?***"

The Massachusetts Institute of Technology Lincoln Laboratories, the United States Army Space and Strategic Defense Command (SSDC), and the Joint Warfighting Capabilities Assessment have

published recent studies on the value of attack operations. Although the Lincoln Laboratories and SSDC studies both show a significant contribution for attack operations, they have narrow scopes. They both address only one target, transporter erector launchers (TELs), use ***TELs killed*** as the measure of effective (MOE) to determine the value of the attack operations' contribution to TMD, and are single Service oriented. Statistics of two wars (World War II and Operation Desert Storm) show no confirmed kills of TELs, yet attack operations made other significant contributions in both wars.

In World War II. the German V-2s were finally defeated by a combination of allied bombing of the production infrastructure and ground troops overrunning the launcher positions in the field. Similarly, there were no absolute verifications of TELs killed in Desert Storm even though approximately 40% of all air sorties and a substantial number of special operations forces were diverted to hunting Scuds. However, attack operations against the command and control (C2) nodes of the Iraqi war machine made the achievement of air superiority quite easy and likely impacted Scud operations. Iraq had over 600 Scuds and only launched 88. It is difficult to determine if the others were suppressed by the air sorties and the activities of the special operations, Army aviation, artillery, tactical air, and Naval aviation forces of the Scud hunt. The value of suppression should not be discounted. It may be a significant contribution of attack operations.

JP 3-01.5 states that attack operations include such actions as destroying launch platforms; Reconnaissance, Intelligence, Surveillance. and Target Acquisition platforms: C2 nodes; and missile stocks and infrastructure. So. an analytical study should not be restricted in target sets. The *Joint Warfighting Capability Assessment - TMD Attack Operations Study* offers an excellent list of nodes in the infrastructure that are prime targets for attack operations.

Point(s) to be Resolved

The current studies show there is some contribution by attack operations. Assuming that there is a significant contribution. it can impact the force level and the size of missile buys for active defense systems. Patriot Advanced Capability-3 is the first system that will require such a decision and that is scheduled for Fiscal Year 1998. Therefore. definitive analysis of this issue needs to be completed before that time.

In order to be helpful, simulations and analyses need to address the issue from a fully joint perspective, treat a full set of targets with all appropriate weapons systems, and assess the results with a comprehensive set of MOE. Then, a transformation formula will be needed to translate the success of attack operations into reduced burden on active defense. In other words, ***How many enemy TELs have to be destroyed during prelaunch or how much damage must be inflicted on the TM infrastructure to reduce the buy of active defense interceptors by <u>one</u> round?***

Decisions on this issue must be tempered with a degree of skepticism on the reliability of modeling and simulation data. We must err on the side of asset and force protection.

Issue 7: Should airborne boost-phase intercept weapons be expected to reduce the burden on terminal active defense systems to the extent that planned procurements should be altered?

Background

There are two advanced technologies (airborne laser (ABL) and airborne boost-phase kinetic energy interceptor) which may be leveraged to contribute to theater missile defense. Both technologies may be able to take on active defense roles and reduce some of the burden on terminal active defense systems. The issue is when and how much can they contribute.

REFERENCES

- U.S. Air Force Scientific Advisory Board Report, *Data Validation for the BMDO TMD COEA*, 4 Apr 95 (Ref. 132)
- SSDC briefing, *Joint Theater Missile Defense--Reducing the Number of Active Systems*, 6 Sep 95 (Ref. 28)

Position 1

ABLs and airborne boost-phase kinetic energy interceptor programs should be accelerated. These two systems offer the most effective method for countering theater missiles.

Position 2

Both systems should continue to be evaluated thoroughly and remain in technology development, without diversion of funds from core programs.

Discussion

The ABL uses an onboard infrared seeker to detect threat missiles in boost-phase after they break cloud cover, which is nominally about 11 kilometers (km) in altitude. The Air Force Scientific Advisory Board claims that the ABL can be effective from this altitude up to about 40 km if the threat missile remains in the boost-phase for that long. They further suggest the use of the airborne interceptor (ABI) in a kinetic energy warhead intercept role between the altitudes of 40 to 70 km while still in the ascent phase. However, even though ABI is a kinetic kill vehicle, they acknowledge that neither system will result in a warhead kill. The damaged missile will, instead, fall short of its intended target and the shortfall could be as much as 100 km. This limited shortfall gives rise to the following concerns.

If the missile were fired at a target in the Corps or echelons above Corps area of friendly forces, the damaged missile could land on front-line maneuver forces, another critical military target, or a geopolitical target.

On the other hand, there are reasons that support defeating ballistic missiles in the boost-phase. First, it is likely to create a deterrence for the continued use of ballistic missiles once an enemy sees that his efforts can easily be countered. Next, it may cause ballistic missile and/or warhead debris to fall on the enemy instead of falling on friendly territory. But if not, the question remains, ***"can an ABL or ABI sufficiently defeat a threat missile in the boost-phase so that friendly forces, key terrain, population centers, and other critical assets are not endangered by missile and warhead debris?"***

Point(s) to be Resolved

The only other active defense system that is intended to intercept threat missiles in the ascent phase is the Navy Theater Wide (upper-tier) system. Consequently, ABL and ABI become an alternative materiel solution to Navy Theater Wide for this mission. For this reason, resolution of the following technical, practical, and operational issues would be appropriate before major acquisition decisions are addressed on Navy Theater Wide, the first of which is proposed for Fiscal Year 1997.

The foremost technical matter is the lethality question. The ABL and ABI must impart sufficient lethality so that an intercepted theater ballistic missile ceases to be a risk to operations on the ground. Then come questions of practicality. ABL or ABI systems must be developed and placed in operation in sufficient quantities to be helpful at affordable costs and in a timely manner. Operational questions regarding the number of aircraft needed to support and sustain ABL and ABI system deployments, the degree of air superiority required, logistical support procedures, and the impact of weather all need to be resolved.

Issue 8: Do short-range ballistic missiles present a significant military threat requiring active defense systems to protect forward positioned maneuver forces?

Background

Bryon Greenwald traces the history of rockets and missiles in warfare in his *Scud Alert* paper. From World War II to the present time over 5,300 short-range ballistic missiles (SRBMs) have been used in warfare. Over half of those have been used in the last ten years. The Systems Planning Corporation's *Ballistic Missile Proliferation Report* of 1992 shows that SRBMs are awesome terrorist weapons and present a significant geopolitical threat. However, debate stems over whether or not today's SRBMs present a significant military threat requiring the development of active defense systems specifically designed to protect forward positioned maneuver forces from that threat.

Position 1

The current inventory of very short-range and short-range ballistic missiles does not present a significant threat to the overall mission accomplishment and welfare of forward maneuver forces.

Position 2

Because of their potential to carry weapons of mass destruction (WMD), SRBMs pose a significant threat to forward maneuver forces.

Discussion

The National Security Strategy recognizes that SRBMs pose a threat to the United States, allies, and other friendly nations because of their potential to carry WMD. In his *Scud Alert* paper, Bryon E. Greenwald points out that Russian Scud technology, at one time or another, has been armed with nuclear, chemical, and biological warheads.

The debate over the reality of a significant military threat stems from accuracy and performance of the current inventory. Most of the current inventory is based on Scud technology and one could argue that Scuds do not have sufficient accuracy to be a significant threat to military targets. Martin Navias states in his book, *Going Ballistic: The Build-up of Missiles in the Middle East*, that to present a threat to military targets, the missile must

REFERENCES

- Greenwald, Bryon E., *Scud Alert! The History, Development and Military Significance of Ballistic Missiles on Tactical Operations*, The Land Warfare Papers, No. 22, Oct 95 (Ref. 112)
- Systems Planning Corporation. *The Ballistic Missile Proliferation Report. An Emerging Threat*, 1992 (Ref. 122)
- A National Security Strategy of Engagement and Enlargement, Feb 95 (Ref. 120)
- Navias, Martin. *GOING BALLISTIC: The Build-Up of Missiles in the Middle East*. Brassey's, 1993 (Ref. 116)
- Schomisch, J. W., *1994/95 Guide to Theater Missile Defense*, Pasha Publications, Arlington, VA. 1994 (Ref. 117)
- *The United States Army 1996 Modernization Plan. Annex G. Missile Defense*. 22 Dec 95 (Ref. 115)

have an accuracy that yields a circular error probable (CEP) of less than 100 meters. Greenwald shows that most Scud derivatives have CEPs that range from 400 to 1,000 meters.

Theater missiles now add a new dimension in warfare. Even after friendly forces have achieved air superiority over manned aircraft, an adversary can employ missiles as a credible threat to be delivered through the air. Theater missiles also extend the range of the battlefield. Schomisch shows, in his *1994/95 Guide to Theater Missile Defense*, that approximately 33 countries around the world now have SRBMs and the trend of their use in regional conflicts is increasing over time. Intelligence estimates show that accuracies will improve over the course of this decade.

The *1996 Army Modernization Plan* emphasizes that the presence of SRBMs could have a serious impact on force projection operations. In the predeployment phase of an operation, the use or threatened use of missiles on population centers in the Joint Force Commander's (JFC) area of responsibility could prevent the United States from garnering enough support to deploy forces. During deployment, missiles could be used to damage ports and airfields and inflict enough casualities to prevent the JFC from establishing a lodgment. Should a lodgment be established, use of ballistic missiles could prevent the JFC from marshaling enough combat power to initiate and sustain decisive operations. During combat, the use of theater missiles might restrict the JFC's freedom to maneuver and preclude the massing of forces at the decisive time and point on the battlefield.

A further complication comes from the fact that there are currently no theater missile defense-capable active defense systems in a position to provide protection to the forward area. Although the maneuver forces may be in armored vehicles or in prepared positions, they are vulnerable to ballistic missile attacks. They have only the Stinger air defense systems for protection. Stinger has some capabilities against air breathing threats, but none against ballistic missiles. Patriot's rearward location puts it out of reach to protect most forward area assets. Navy Area Defense is restricted to littoral operations and may not have sufficient reach to protect the forward area. Only the Medium Extended Air Defense System (MEADS) has a requirement to provide this protection. When and if MEADS is deployed, it may not be in sufficient numbers to provide a credible defense for this threat.

Point(s) to be Resolved

There are two sub-issues requiring analysis. One is to characterize the magnitude of and military risk associated with theater missiles targeted against forward maneuvering forces. In order to resolve this issue, simulations and analyses must be conducted on all effects posed by the use, or threatened use, of SRBMs. As pointed out by Greenwald, in his *Scud Alert!* paper, there are three types of effects. Primary effects are those effects that directly impact tactical forces. Secondary effects are indirect effects that are caused by a response to the use or threatened use of SRBMs. In Desert Storm approximately 40% of United States air sorties were diverted to the Scud hunt in the Iraqi desert. This represented a major diversion of combat power from other high priority targets. The third type is the effect of these weapons on the commander's battle space. SRBMs stretch the commander's area of interest and greatly increase his target list.

The other point to resolve is whether or not forward area maneuver forces should have a priority for active defense systems. The forward forces are not usually protected by active defense from enemy field artillery (canon, howitzer, mortar, and rocket) systems. Attack operations, in the form of counterbattery fires, and passive defense measures are the primary elements of defense against these systems. Simulations and analyses must be conducted to determine the significance of the SRBM threat and if MEADS is actually required for the protection of maneuver forces. Furthermore, the force level of MEADS required to provide a credible defense must be determined. In order to provide decision makers with better information, all of these areas should be assessed prior to the MEADS acquisition decision currently scheduled for Fiscal Year 1998.

REFERENCES

- *Corps Surface-to-Air Missile (Corps SAM) Cost and Operational Effectiveness Analysis (COEA)*, Technical Report TRAC-TR-0393 (U), Sep 93 SECRET (Ref. 59)
- *ORD for the Corps SAM System* (U), 5 Oct 93 SECRET (Ref. 93)
- Corps SAM briefing for the BMD Program Review, 14 Sep 95 (Ref. 33)

Issue 10: What are the potential conflicts for evolving Patriot Advanced Capability-3 into a Corps Surface-to-Air Missile/Medium Extended Air Defense System-like system?

Background

The Army's acquisition strategy for developing a Corps Surface-to-Air Missile (SAM) capability involves participation in the Medium Extended Air Defense System (MEADS) program, a joint international cooperative effort with Germany, France, and Italy. This program is currently in the Project Definition-Validation phase with two international teams developing competing Corps SAM/MEADS designs. A down select decision is planned for Fiscal Year (FY) 1999 with fielding scheduled for FY 2006. The United States is providing 50% cost share for the MEADS program.

Position 1

The United States should participate in the MEADS international program to develop a Corps SAM-like system.

Position 2

The United States should evolve Patriot through pre-planned product improvements into a Corps SAM-like system.

Discussion

The MEADS program provides the opportunity for allies to participate with the United States against a common threat, fostering closer military, economic, and political ties. It also assures international interoperability and provides a basis for an integrated theater missile defense (TMD) architecture for North Atlantic Treaty Organization (NATO) and a sharing of costs. An option to the MEADS requirement is to incrementally product improve the Patriot system to meet Corps SAM requirements. These improvements would center on downsizing and modifying Patriot and existing Army hardware to meet the Corps SAM mobility and deployability requirements. A time-phased product improvement program would build on existing Patriot infrastructure. This approach would allow the flexibility to field an interim Corps SAM-like capability over time, which would respond to the threat and still meet the Army's requirements to protect maneuvering units.

Corps SAM is designed to provide defense against fixed and rotary wing aircraft, cruise missiles, unmanned aerial vehicles, and short- to medium-range theater ballistic missile (TBM) threats to the corps critical assets and ground forces. This mission requires a highly mobile system that can move with the ground forces and can be rapidly deployed to respond to crisis anywhere in the world. The Patriot system does not meet the deployability and mobility requirements of Corps SAM. Because of proliferation, many of our allies are facing a similar threat and do not have a system that is capable of providing TBM and cruise missile defense to their ground forces. More than 20 nations now employ the United States developed Hawk and are now concerned about its replacement. The development of MEADS as a collaborative program would provide the basis for international partnership that could lead to the development of a new system to meet the threat and be affordable by the countries that are considering a replacement for Hawk.

As a result of Operation Desert Storm, Patriot has been upgraded to provide better protection against long range, faster TBMs. The growth and evolution of Patriot to meet the threat demonstrated the product improvement approach that could be used to develop a Corps SAM-like capability. Patriot is a proven and fielded system, which has been sold through foreign military sales to four countries. It is not likely that MEADS partners would collaborate on Patriot evolution vice development of a new system; however, the exception may be Germany, which owns Patriot. MEADS has the potential to be marketed as the Hawk follow-on for most of the 20 nations that now own Hawk.

Point(s) to be Resolved

Allied reaction to a United States decision to evolve Patriot instead of developing MEADS may be politically and economically unacceptable. Additional collaboration on achieving a European/NATO TMD capability would be at risk. Further, overriding political and economic pressure to participate and ensure success in MEADS may result in a system that will not expeditiously meet all United States requirements due to the compromises normally required over time to preserve an international program. The Patriot Advanced Capability-3 decision point in FY 1998 and the MEADS decision point in FY 1999 should incorporate this issue.

REFERENCES

- *CEC in Air Defense Artillery* briefing. USAADASCH. Jan 95 (Ref. 8)
- *CEC Leading the Revolution* briefing (U). 17 Oct 95 SECRET (Ref. 44)
- *BMDO Cruise Missile Defense ACTD* (Phase I. Mountain Top). 1995 (Ref. 113)

Issue 11: Should the Joint Staff endorse the Navy's Cooperative Engagement Capability for joint and land-based theater ballistic missile defense operations?

Background

The Navy's Cooperative Engagement Capability (CEC) is designed to network ships, aircraft, and land-based sensors information to improve warfighting effectiveness. CEC accepts data from all sensors in the network and provides fused and correlated fire control quality data to any network "user" so the data from any sensor in the network can be used as if the data were generated by the "user's" organic sensors. Potentially, each unit uses all of the data from all of the sensors in the network to construct a high quality composite track file that is identical at every unit in the network. Because the CEC data is accurate and timely enough it is generally capable of being used for fire control throughout the network.

In addition to providing data distribution improvements, CEC increases weapons system effectiveness by providing composite radar data of fire control quality. CEC will initially be implemented in support of the Navy anti-ship cruise missile defense mission and has application for theater ballistic missile defense (TBMD) role. As of March 1995, CEC was installed on five Navy ships and on one aircraft. The Navy plans to install CEC on its guided missile cruisers and destroyers, aircraft carriers, amphibious ships, and E-2C aircraft. It is additionally seeking connectivity to the Air Force Airborne Warning and Control System (AWACS) force and to the Army's land-based air defense radars.

Position 1

Navy CEC should be adopted as the standard sensor integration management system for theater missile defense (TMD).

Position 2

Navy CEC should be assessed further before designation as the joint standard. Cost effectiveness in a non-maritime role is a major concern.

Discussion

The Army, Air Force, and Marine Corps are currently evaluating the potential benefits of incorporating CEC features into Patriot, Theater High Altitude Area Defense (THAAD), AWACS E-3A, AN/TPS-59 radar, advanced airborne fire control aircraft, and on platforms providing infrared surveillance and tracking.

The Navy believes CEC has the potential to provide the following improvements for joint and TBMD operations: Patriot, THAAD, and Aegis cued engagements and interceptor commit on composite data; correlation of AWACS track measurements with Aegis SPY-1; Patriot and THAAD radar data to improve track continuity and identification; coordinated use of Patriot, THAAD, and Aegis resources for missile conservation; coordinated allocation of ground and fire control radar/illuminator resources for anti-ship and land-attack cruise missile engagements; and improved identification and situational awareness. (In some scenarios, Navy ships may be in position so their radars can view a theater ballistic missile trajectory before a Patriot or THAAD can detect the missile.)

The Army Air Defense Artillery School at Fort Bliss is currently assessing the ability to pass fire control data from a non-organic sensor to an organic fire control radar during the Mountain Top demonstrations. Fort Bliss estimates that incorporating CEC into Patriot Advanced Capability-3 (PAC-3) will cost $25-30 million per battalion. This integration is likely to be complex and include both hardware and software changes. Because the Patriot system is range limited due to the missile, not the radar, a CEC upgrade would only marginally increase performance, but could extend detection range against low flying cruise missiles and aircraft. The Army acknowledges that CEC technology has the potential to improve joint TMD battle management, but is concerned that it will be costly.

how many battalions?

Point(s) to be Resolved

Cost effectiveness of adapting CEC as the standard sensor integration management system is an issue for both the Army and Navy. The decision should be incorporated into PAC-3 and Navy Area Defense decision points.

REFERENCES

- *THAAD Program Overview* briefing. prepared by THAAD PMO. 14 Sep 95 (Ref. 35)
- *THAAD System Growth Options for Navy Upper-Tier Mission* briefing. 8 Sep 95 (Ref. 31)
- *Joint Force Directorate (AQI) Theater Missile Defense User Handbook.* Mar 95 (Ref. 121)
- *Assessment of Navy Upper-Tier Roles. Capabilities. and Technical Solutions* briefing. PEO-MD. 12 May 95 (Ref. 15)

Issue 12: How meaningful would a Theater High Altitude Area Defense - Navy Theater Wide demonstration or competition be if the intent is to down select to a single system?

Background

The report of a recent theater missile defense (TMD) review has suggested an upper-tier "shoot-off" between the Army Theater High Altitude Area Defense (THAAD) and Navy Theater Wide systems in or around Fiscal Year (FY) 2002. The initiative for the shoot-off seems driven by the need to reduce TMD budgets in the out-years. The shoot-off would become a vehicle to down select to a single upper-tier system or missile. Options for a shoot-off include selection of an upper-tier system for use by both the Army and the Navy. selection of a common missile and/or kill vehicle. or assignment of the upper-tier mission to a single service.

Position 1

TMD requirements and projected TMD funding do not support the fielding of an upper-tier system for both the Army and the Navy. A shoot-off is required to down select from these two competing systems to a single system that will meet all TMD requirements.

Position 2

The upper-tier systems developed by the Army and the Navy are unique to each Service's requirements and mission and have different operational concepts for the engagement battlespace. A better approach to a reduced TMD budget is to review and adjust the Service's acquisition strategies to match the available funding.

Discussion

The Army's THAAD program is currently in the demonstration/ validation development phase with a Milestone II decision review scheduled for FY 1997 with an initial fielding in FY 2002. The THAAD User Operational Evaluation System (UOES) is being developed as part of the demonstration and validation phase which will provide a deployable system in FY 1997 for contingency operations by a Theater Commander-in-Chief in support of a national emergency.

The Navy Theater Wide system is being designed to be compatible with the Standard Missile-2 Block IV and existing shipboard

vertical launch hardware. The Navy is conducting a cost and operational effectiveness analysis to select an upper-tier design. A milestone review and program start date has not been established. Given a program start in FY 1996/1997, the Navy could have a UOES equivalent system available for comparison against THAAD by FY 1999/2000.

A FY 2002 comparison shoot-off and down select would most likely result in delaying a first unit equipped (FUE) for an upper-tier system until FY 2007. In order to conduct a FY 2002 shoot-off, the THAAD program would have to be slowed down so that the Navy program could catch up.

There are significant technical and design differences between THAAD and Navy Theater Wide systems because of the unique requirements and missions of the Services. THAAD is designed to intercept theater ballistic missiles (TBMs) in the late midcourse and terminal phase of their trajectories. Navy Theater Wide intercepts will occur in the ascent and midcourse phase of the trajectory. The THAAD kill vehicle has slower impact velocity but a higher warhead kill vehicle weight than the Navy Theater Wide kill vehicle which has a higher velocity but a lighter mass. Because of the Service's requirements and differences in design concepts, a THAAD/Navy Theater Wide shoot-off will discover many points of contrast and less points for comparison.

The Defense Intelligence Agency predicts that the medium-range TBM threat will begin to increase in quantity in FY 2004-2005 timeframe. The current THAAD program meets the current threat with the UOES system in FY 1997 and counters this threat growth with an operational system FUE in FY 2002. Delaying the THAAD program to allow for a FY 2002 shoot-off would create a window of risk between FY 2002 (THAAD FUE) and FY 2007 (upper-tier FUE based on a shoot-off strategy) with only the THAAD UOES system available to counter the increasing medium-range threat during the period FY 1997 through FY 2007.

Point(s) to be Resolved

Is there a need to select a single system for the upper-tier mission? Is the potential military risk associated with a delayed development of THAAD advisable to accept? Will the dissimilar competition answer significant questions that cannot be answered through study and analysis? This issue requires near-term resolution.

APPENDIX B: SUMMARIES OF DESIGNATED STUDIES

Introduction

Appendix B is classified Secret/WNINTEL and issued separately in the Classified Supplement to *A Theater Missile Defense Integration Study*. In that appendix appear limited summaries of the studies listed below. The summaries provide a one-point source for some of the current TMD analytical work. Parenthetical citations refer to items in Appendix E.

- **Defense Planning Board/Defense Science Board Joint Task Force on Theater Missile Defense (Ref. 130)
- *Theater Missile Defense Program Update Study for 1995 (Ref. 14)
- *Joint Area Cruise Missile Defense Study (Ref. 134)
- *Overview and Summary of Preliminary Findings for the Theater Missile Defense Capstone Cost and Operational Effectiveness Analysis (Ref. 61)
- *North Atlantic Treaty Organization Defense Group on Proliferation. Active Defense Subgroup Report (Ref. 136)
- *Threat and Mission Priorities Report. Organization of the Joint Chiefs of Staff (J-8) (Ref. 144)
- *Joint Warfighting Capability Assessment -- Theater Missile Defense Attack Operations Briefing. Organization of the Joint Chiefs of Staff (J-8) (Ref. 52)
- Massachusetts Institute of Technology Lincoln Laboratory Attack Operations Study (Ref. 135 and *138)
- Navy Theater Ballistic Missile Defense Briefing (in lieu of Navy Cost and Operational Effectiveness Analysis)
- Ballistic Missile Defense Organization Theater Missile Defense Command and Control Plan Coordination Draft (Ref. **139. **140. **141. and *142)
- *Boost-Phase Intercept Concept Assessment (Ref. 54)

NOTE: Classified references are indicated by an asterisk (*).
Restricted distribution references are indicated by a double asterisk (**).

APPENDIX C: BUDGET VARIATIONS

Introduction

This appendix provides the methodology by which the study team developed options required to meet the $2 billion per year budget guidance.

Added to the theater missile defense (TMD) core programs (Patriot Advanced Capability-3 (PAC-3), Theater High Altitude Area Defense (THAAD), and Navy Area Defense) were those programs supported by the Services to attain a robust two-tiered capability (Medium Extended Air Defense System (MEADS) and Navy Theater Wide) plus a technology wedge for potential boost-phase programs or other follow-on efforts to establish our base case. The base case exceeded the allowed $2 billion ceiling in every year. Several time-tested, though not necessarily desirable, techniques were employed in a series of sequential steps to reduce the annual expenditures. These techniques included reducing procurement quantities, stretching both development and procurement cycles, postponing program initiation, and replacing a new start program with a modification program to further upgrade an existing system.

These steps and the resulting options are depicted in the series of charts beginning on the following page and continuing through page C-10. All initial baseline funding information was extracted from either the Ballistic Missile Defense Organization (BMDO) Fiscal Year (FY) 1997-2001 Program Objectives Memorandum (POM) submit or the TMD Cost and Operational Effectiveness Analyses data input.

BMDO POM Funding:

Core Programs

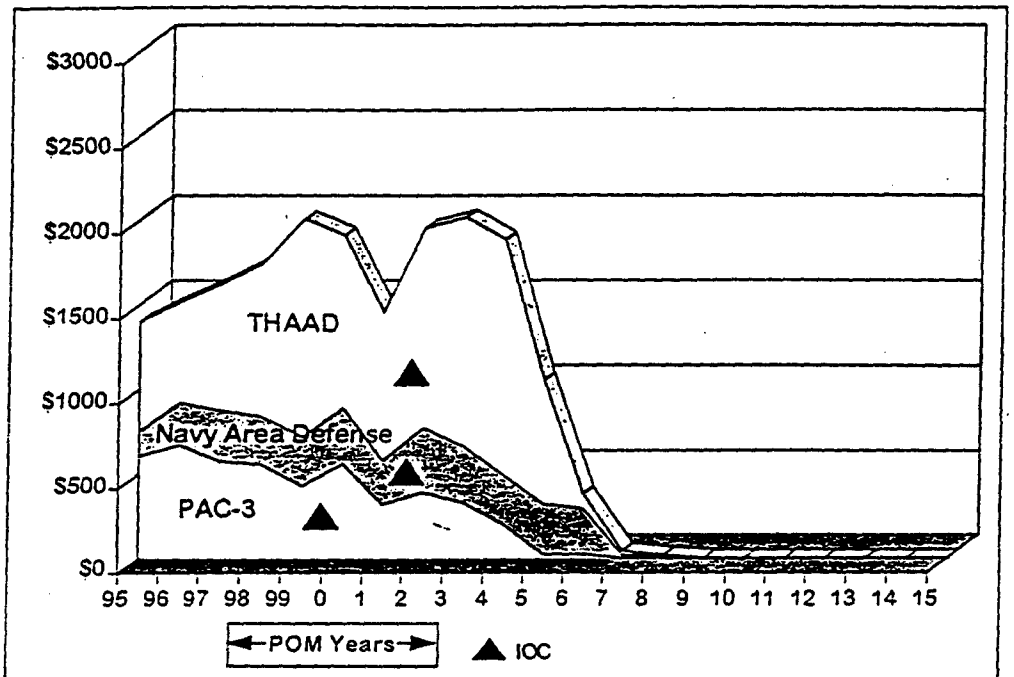


Figure C-1: Core Programs

Core Programs:

- Can be fully funded within funding guidance
- Counter threats through 2005
- Provide upper-tier User Operational Evaluation System (UOES) capability in FY 1998 and objective capability in FY 2002

But:

- Do not provide advanced lower-tier capability (MEADS)
- Do not provide advanced upper-tier capability beyond THAAD
- Do not provide Advanced Technology funds for exploring future capabilities

BMDO POM Funding:

Core Programs + MEADS and Navy Theater Wide Estimates

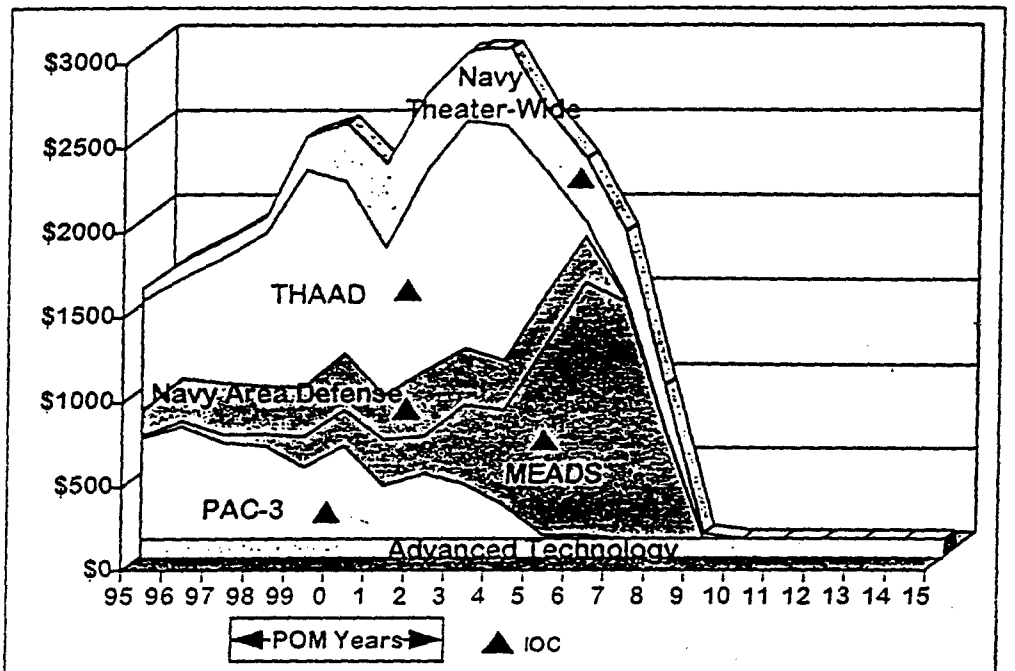


Figure C-2: Funding for All Proposed Programs

Proposed Programs:

- Fully fund PAC-3 and Navy Area Defense lower-tier programs
- Fully fund THAAD for FY 2002 Initial Operational Capability (IOC) and two battalions Full Operational Capability (FOC)
- Provide near-term technology/demonstration efforts for Navy Theater Wide with MS II in FY 1999 and IOC in FY 2006
- Fully fund MEADS to support FY 2006 IOC
- Provide wedge for Advanced Technology efforts to investigate follow-on capabilities, support Air Force Boost-Phase Intercept (BPI), accelerate Navy Theater Wide, etc.

But:

- Do not meet funding guidance

STEP 1:

PAC-3 Missile Buy Reduced from 1200 to 600

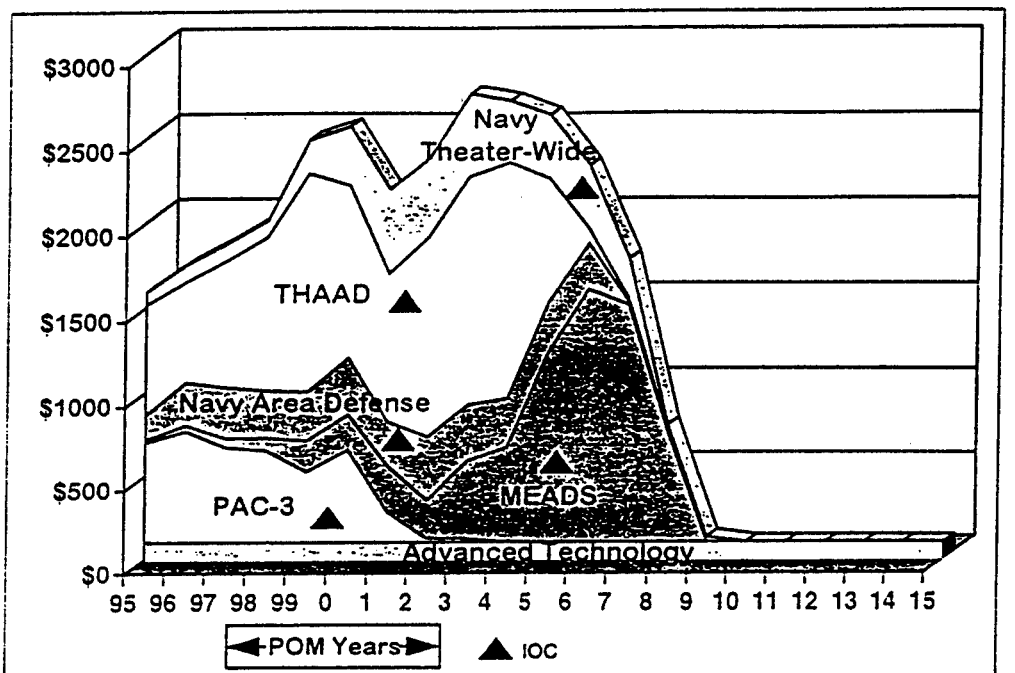


Figure C-3: PAC-3 Missile Buy Reduced

Step 1:

- Frees up out year funds to apply to advanced systems
- Decision is reversible until FY 1998 without cost penalty

But:

- Increases unit cost of PAC-3
- Reduced capability until advanced system is fielded
- Does not help near-term funding problem

STEP 2:

Step 1 + THAAD Reduced from 2 Battalions to 1 Battalion

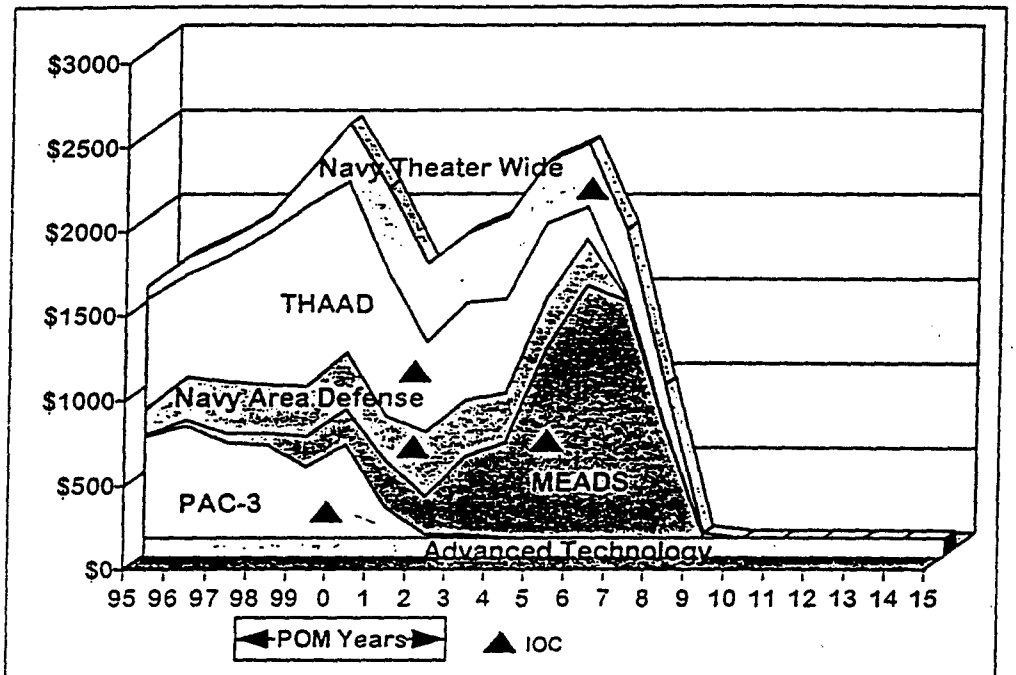


Figure C-4: THAAD Reduced

Step 2:

- Reduces expenditures in out years
- Maintains advanced upper-tier capability IOC in FY 2002
- Reduced quantity can be subsidized by Navy Theater Wide capability
- Consistent with Army decision not to support force structure for second battalion

But:

- Increases unit cost
- Reduces Army ability to do two Major Regional Contingencies (MRCs) without support from Navy Theater Wide
- Still does not meet funding guidance

OPTION 2a:

Step 2 + Extend THAAD Research and Development 2 Years

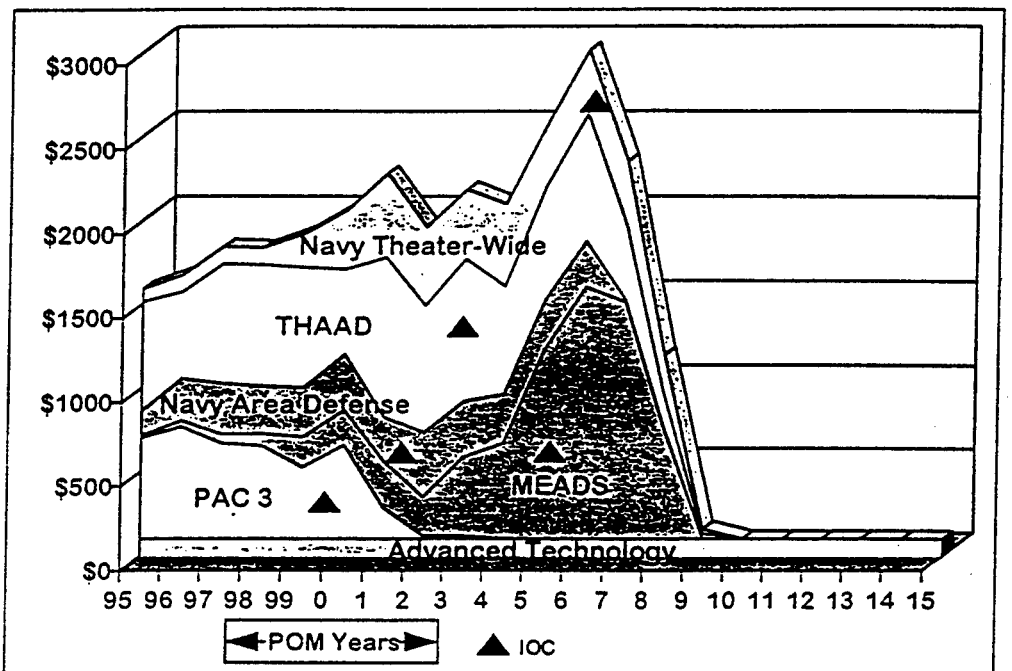


Figure C-5: Extend THAAD

Option 2a:

- Comes close to meeting funding guidance in POM years
- Reduces schedule risk in THAAD development program
- Delays procurement decision two years

But:

- Delays IOC two years to FY 2004
- No upper-tier capability, other than UOES, fielded in POM years
- Exacerbates funding crunch in out years

STEP 3:

Step 2 + Develop PAC-4 from PAC-3

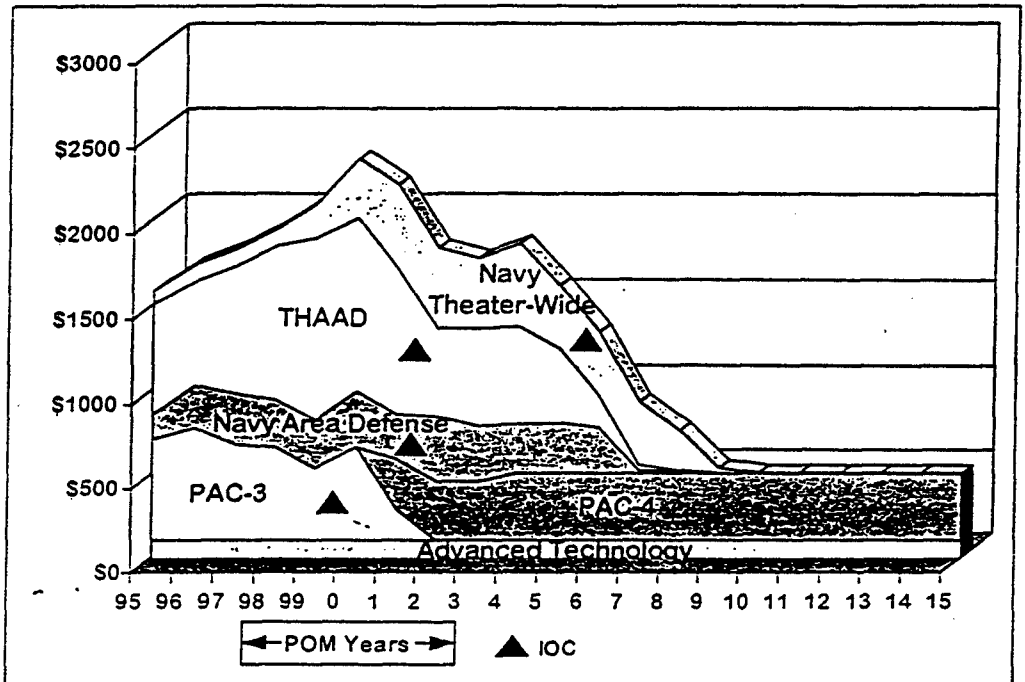


Figure C-6: Develop PAC-4

Step 3:

- Provides adequate funds to develop enhanced deployability, maneuverability, and effectiveness in a Patriot Advanced Capability-4 (PAC-4) system
- Solves funding problem in out years, allows more resources to be applied to upper-tier programs
- Decision not required until FY 1998

But:

- Puts international MEADS program at risk

OPTION 3a:

Step 3 + Extend THAAD Missile Research and Development 2 Years

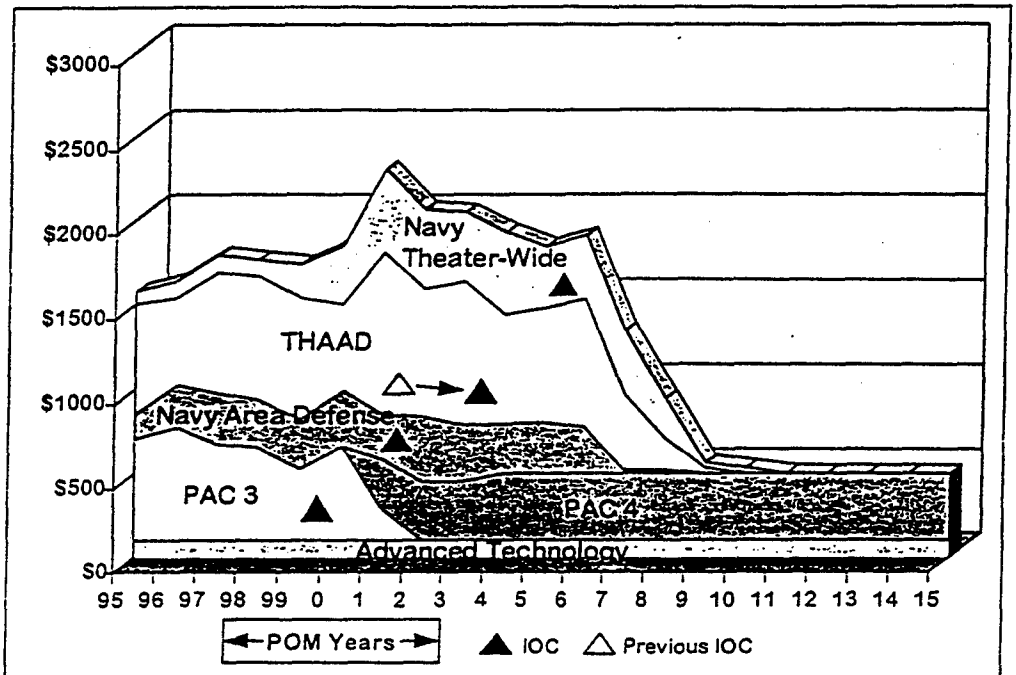


Figure C-7: Extend THAAD

Option 3a:

- Continues PAC-3, at reduced capabilities, on schedule
- Continues Navy Area Defense on schedule
- Develops PAC-4 capability
- Provides Advanced Technology wedge
- Reduces schedule risk in THAAD program

But:

- Delays objective upper-tier capability two years
- Increases cost of THAAD program
- Does not solve POM funding problem

OPTION 3b:

Step 3 + Revise (Stretch) Navy Theater Wide

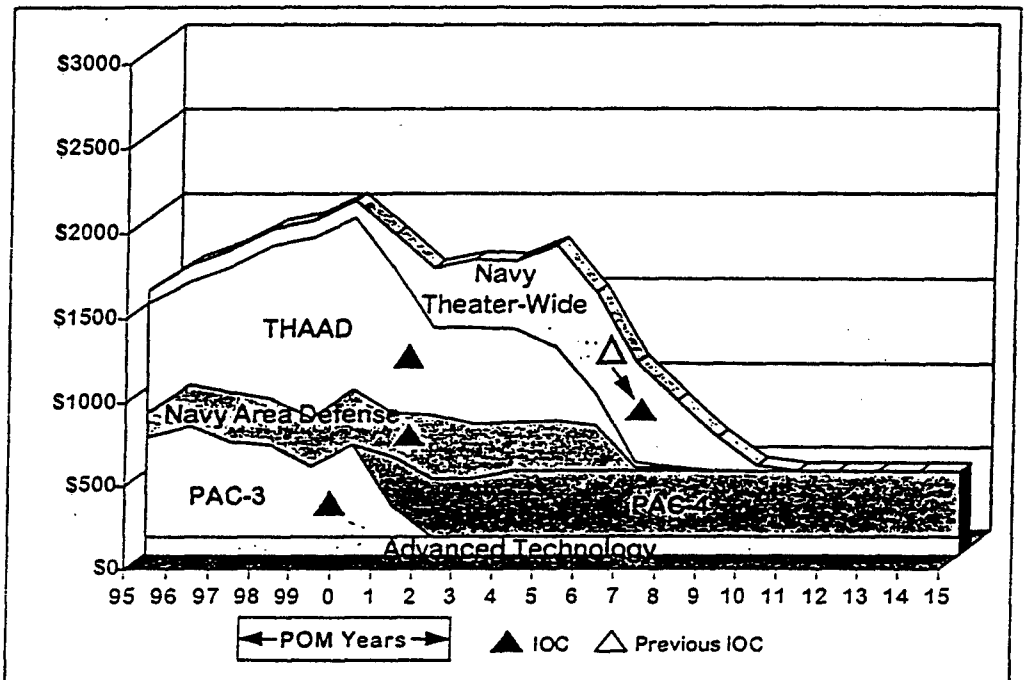


Figure C-8: Revise Navy Theater Wide

Option 3b:

- Meets funding guidance
- Provides upper-tier capability in FY 2002
- Provides increased funding for Navy Theater Wide during procurement phase
- Continues PAC-3, at reduced quantity, on schedule
- Continues Navy Area Defense on schedule
- Develops PAC-4 capability
- Maintains Navy Theater Wide FOC
- Provides Advanced Technology wedge

But:

- Delays Navy Theater Wide IOC approximately one year

PTION 3c:

:ep 3 + 3a + 3b. Extend THAAD and Revise Navy Theater Wide

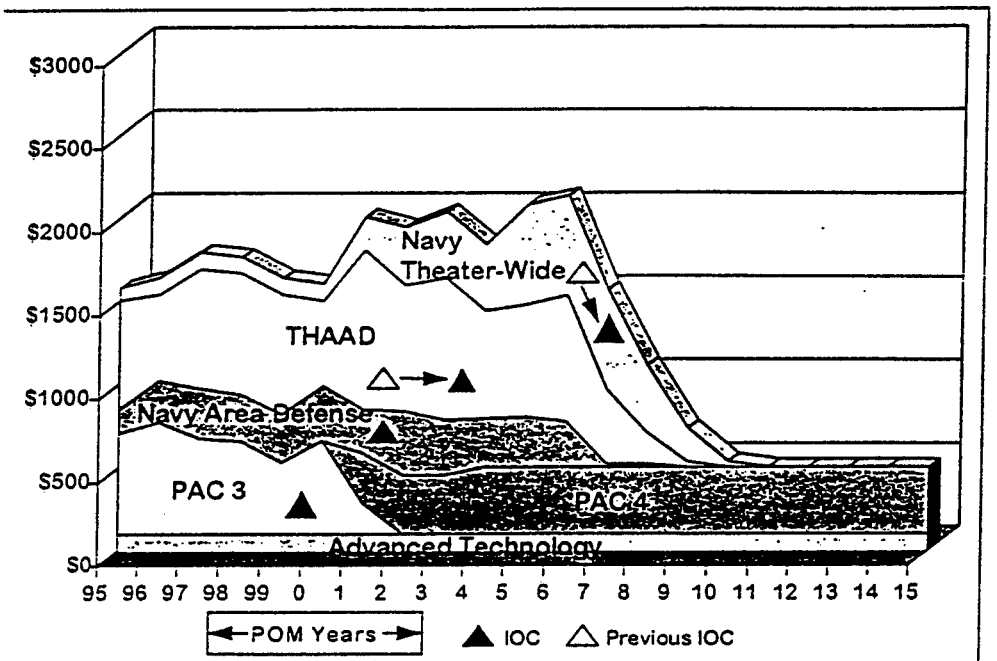


Figure C-9: Extend THAAD and Revise Navy Theater Wide

)ption 3c:

- Meets funding guidance
- Provides robust, though not timely, upper-tier capability
- Provides increased funding for Navy Theater Wide during procurement phase
- Continues PAC-3, at reduced quantity, on schedule
- Continues Navy Area Defense on schedule
- Develops PAC-4 capability
- Maintains Navy Theater Wide FOC
- Provides Advanced Technology wedge

But:

- Delays initial objective upper-tier capability two years
- Increases cost of both THAAD and Navy Theater Wide programs

Subsequent guidance directed a similar exercise using the $2 billion figure as the total allocation for all BMDO efforts less National Missile Defense (NMD). In addition, two variations from this scenario were requested; specifically, one with THAAD capped at $400 million per year and Navy Theater Wide capped at $200 million per year, and a second which would modify the PAC-4 program in our options to provide a reasonable IOC (FY 2005-06) with a realistic procurement schedule to completion.

These variations and options were accomplished using the same techniques as in earlier efforts and are represented by the charts beginning on the following page and continuing through page C-19.

BMDO POM Less NMD

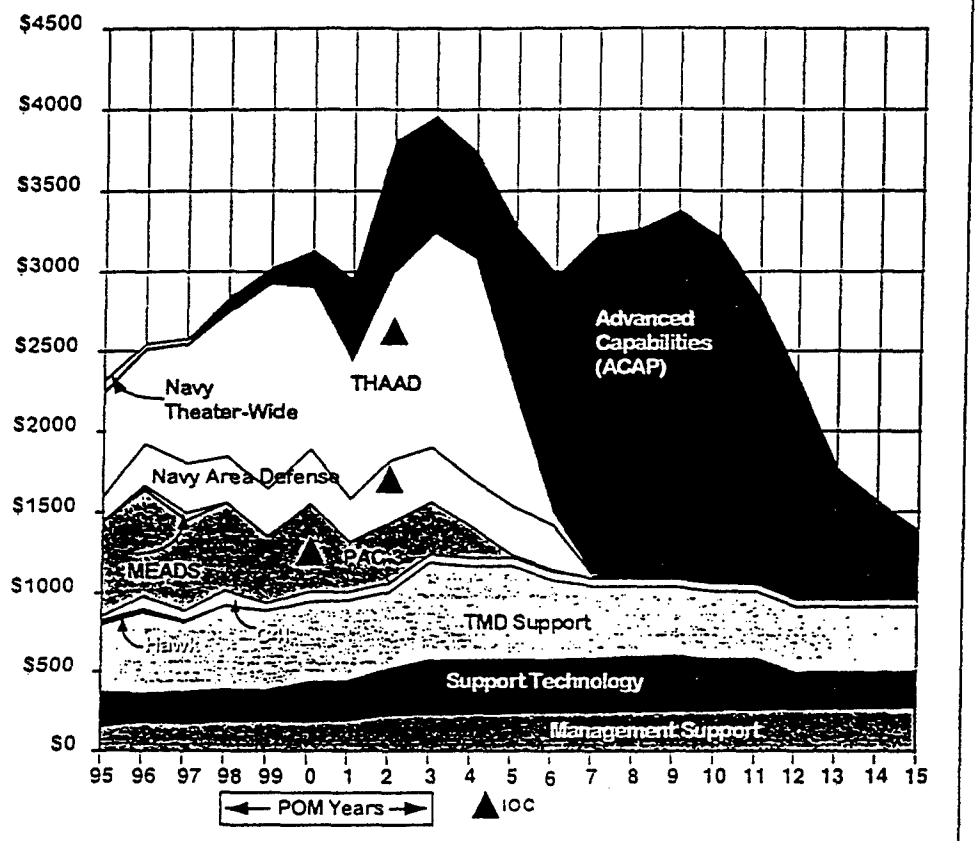


Figure C-10: BMDO POM Less NMD

- Based on BMDO figures available in first quarter of FY 1996
- Hawk, MEADS and Navy Theater Wide funding ends FY 1997
- Support Technology and Management Support apply to TMD and NMD
- Advanced Capabilities line assumes selection of Advanced Concepts for Program initiation

BMDO POM Less NMD, Plus MEADS and Navy Theater Wide to Completion

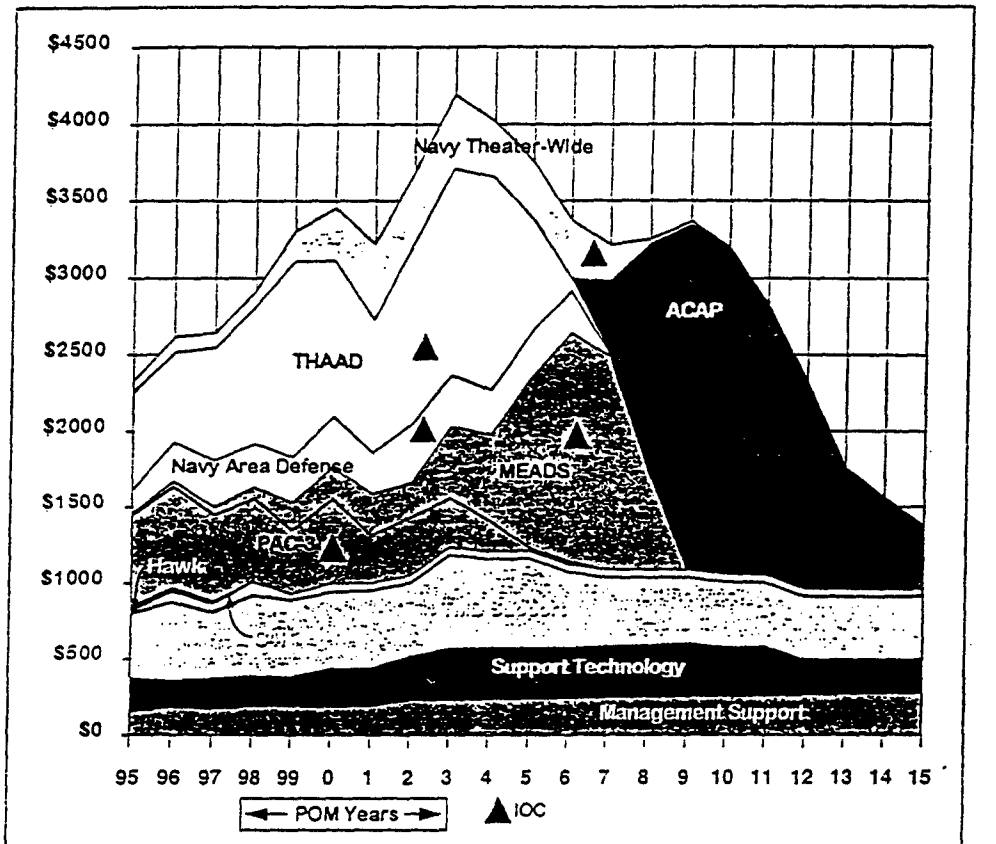


Figure C-11: BMDO POM Less NMD Plus Selected Advanced Concepts

- Army MEADS estimates considered equivalent to United States portion of MEADS
- All IOCs shown are current Service estimates
- MEADS funded from ACAP line to the extent possible

BMDO POM Less NMD, With THAAD Capped at $400 million/year, Navy Theater Wide Capped at $200 million/year, and MEADS Estimate to Completion

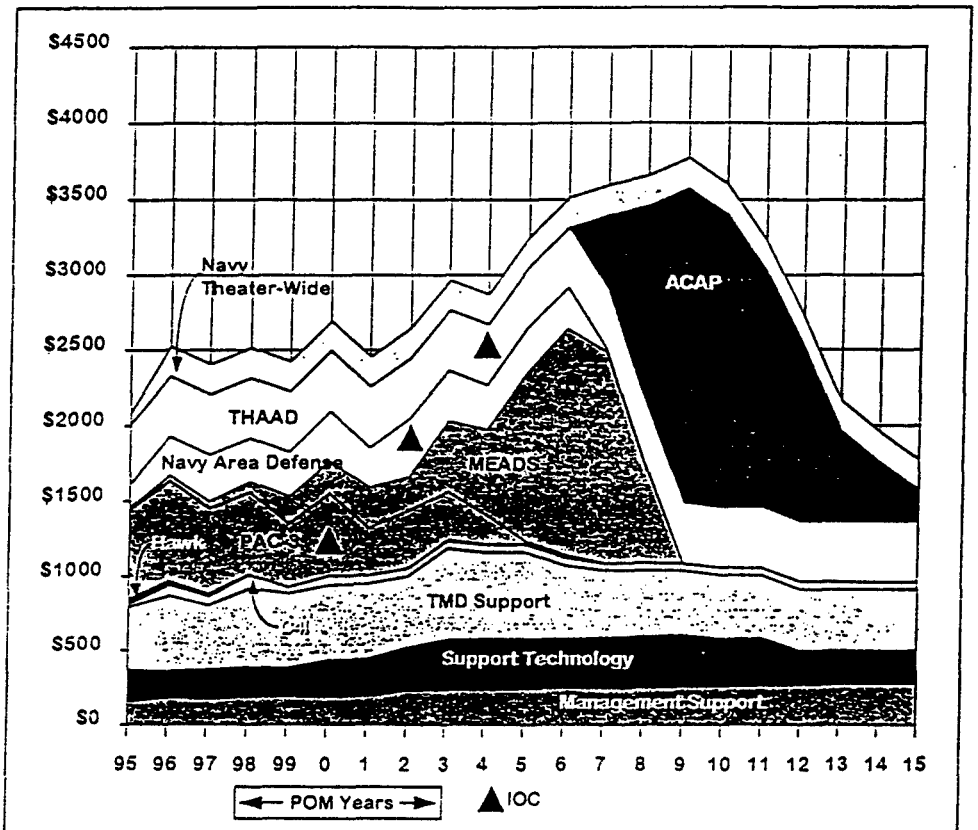


Figure C-12: BMDO POM Less NMD and 400/200 Option

- MEADS and Navy Theater Wide funded from ACAP line to the extent possible

THAAD/Navy Theater Wide Down Select Including Enhanced Funding of PAC-4

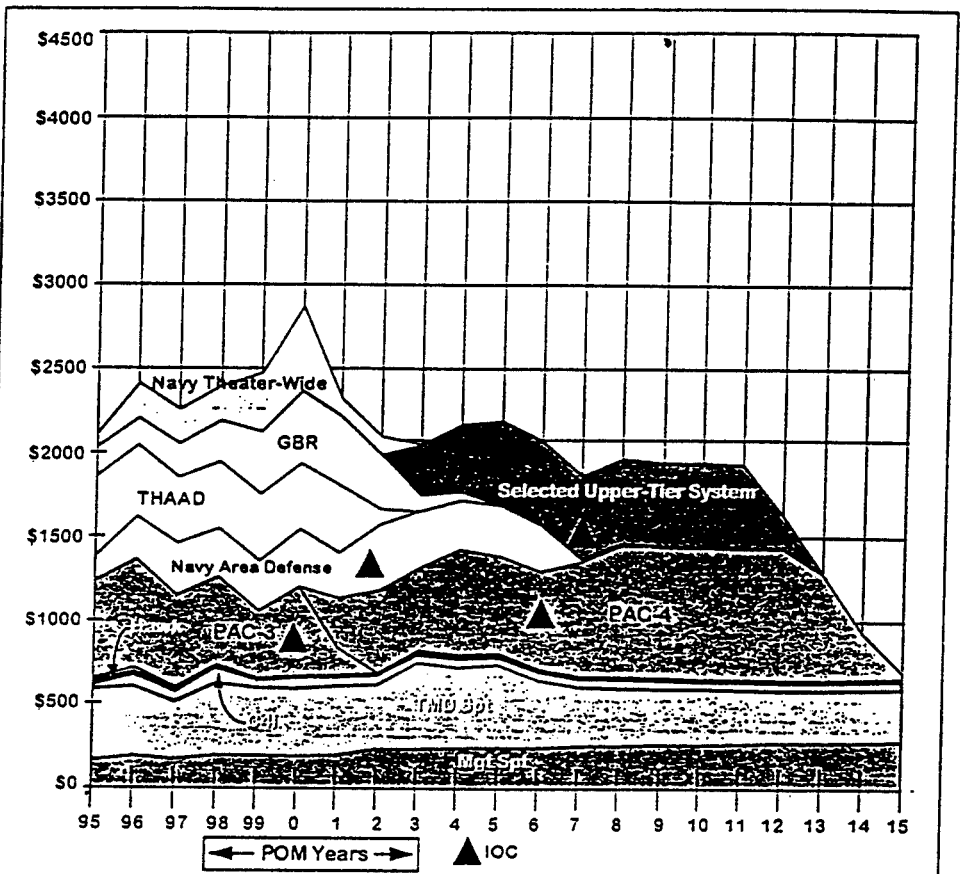


Figure C-13: THAAD/Navy Theater Wide Down Select

- Incorporates PAC-3 reduction to 600 missiles & THAAD reduced to 1 battalion
- Decrement THAAD $150 million per year
- Down select to one upper-tier/medium-range theater ballistic missile defense system in FY 2002
- Ground-Based Radar funded through partial procurement
- PAC-4 given plus-up from ACAP to enable IOC in FY 2006
- Remaining ACAP funds in FY 2006-2013 not shown
- Unallocated. non-punitive cut to TMD Support of $100 million per year
- No non-system specific support technology (currently $173 to $246 million/year)

THAAD Pre-Planned Product Improvement (P3I) With Revised Navy Theater Wide

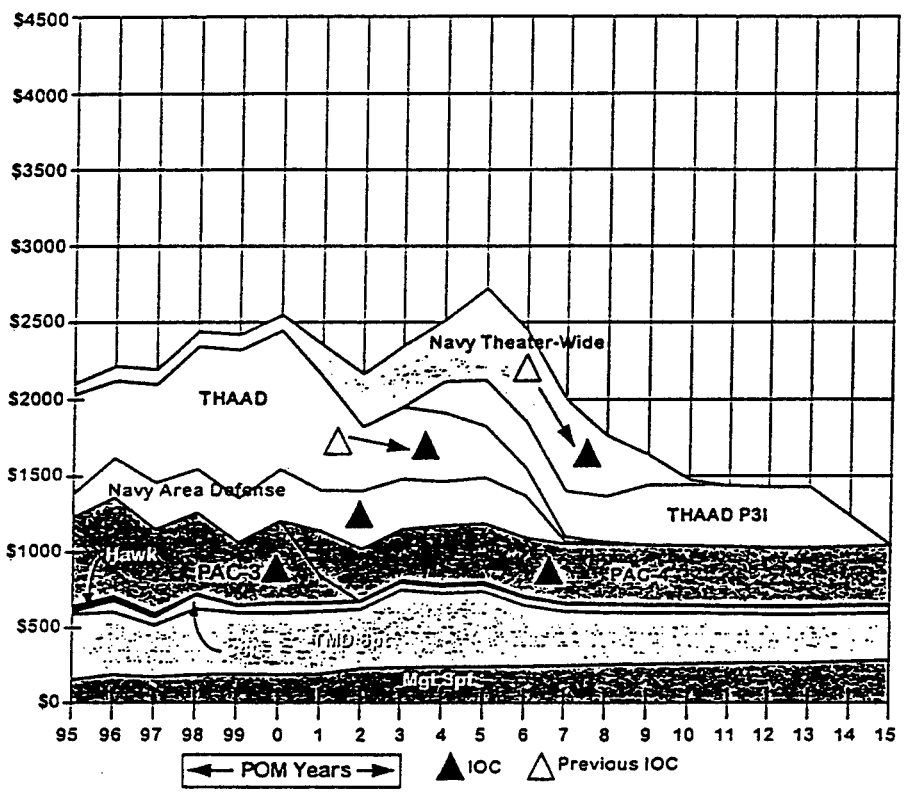


Figure C-14: THAAD P3I

- Two year delay in THAAD IOC
- Two year delay in Navy Theater Wide IOC
- THAAD P3I to be defined based on reassessment of threat and program status
- See page C-15 for description of support adjustments

THAAD P3I With Revised Navy Theater Wide and Enhanced Funding of PAC-4

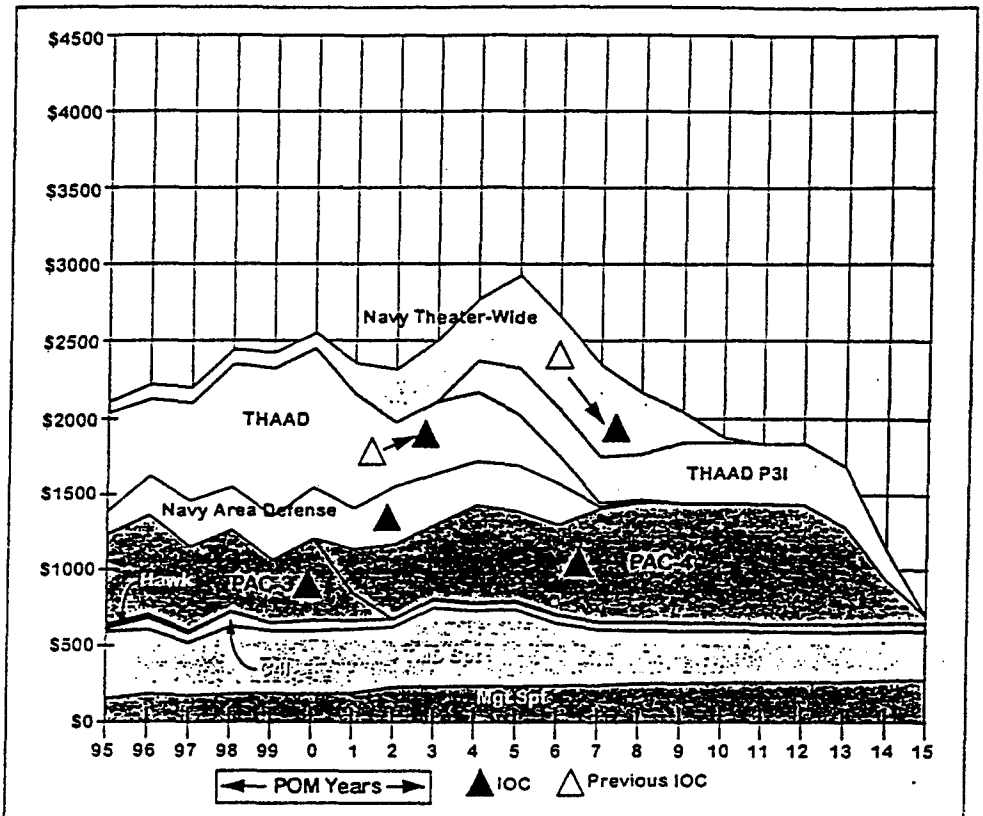


Figure C-15: THAAD P3I/Enhanced Funding of PAC-4

- Step 3 (page C-7) + revise Navy Theater Wide (w/plus-up to PAC-4)
- PAC-4 IOC in FY 2006 matches MEADS IOC estimates
- PAC-4 plus-up based on projections in MEADS funding
- See page C-15 for description of support adjustments

Extended THAAD P3I With Revised Navy Theater Wide

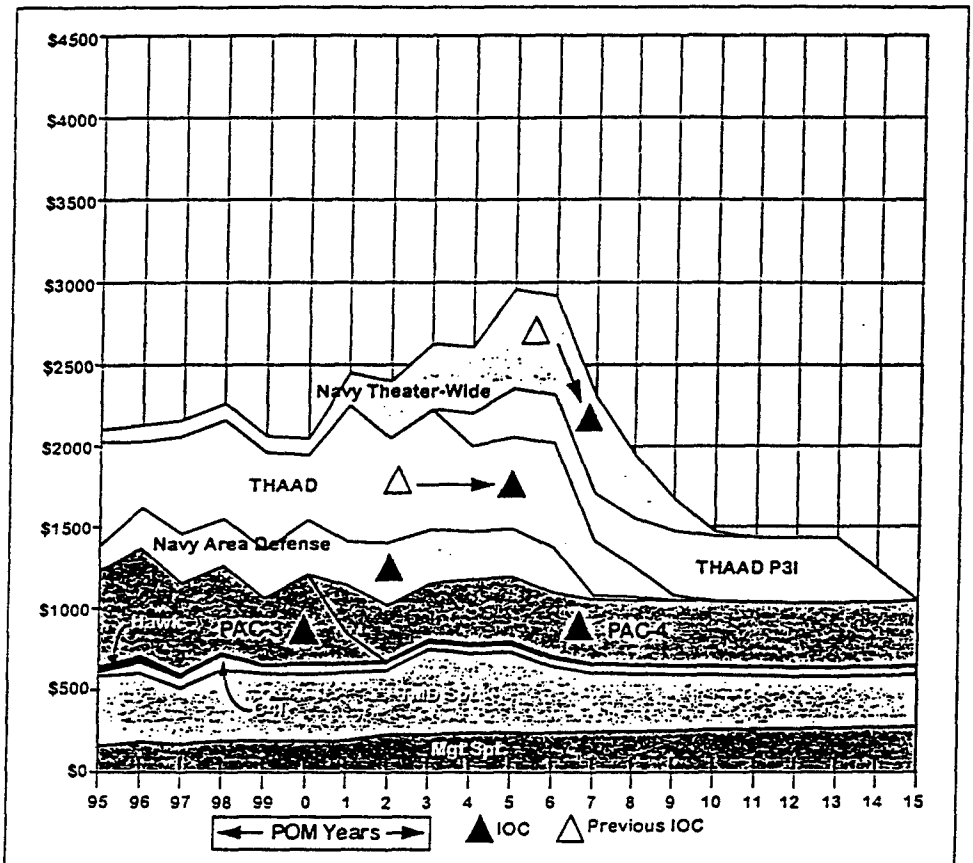


Figure C-16: Extended THAAD P3I

- Option 3c (page C-10), extend THAAD and revise Navy Theater Wide (like Option 3c, began with step 3, incorporated actions under 3a and 3b, then using THAAD P3I, extended THAAD, revised Navy Theater Wide)
- Considerable operational risk, with current threat estimates
- Only upper-tier/medium-range defense prior to FY 2005 would be a THAAD UOES, if available
- See page C-15 for description of support adjustments
- THAAD research and development extended two years

Extended THAAD P3I With Revised Navy Theater Wide & Enhanced PAC-4 Funding

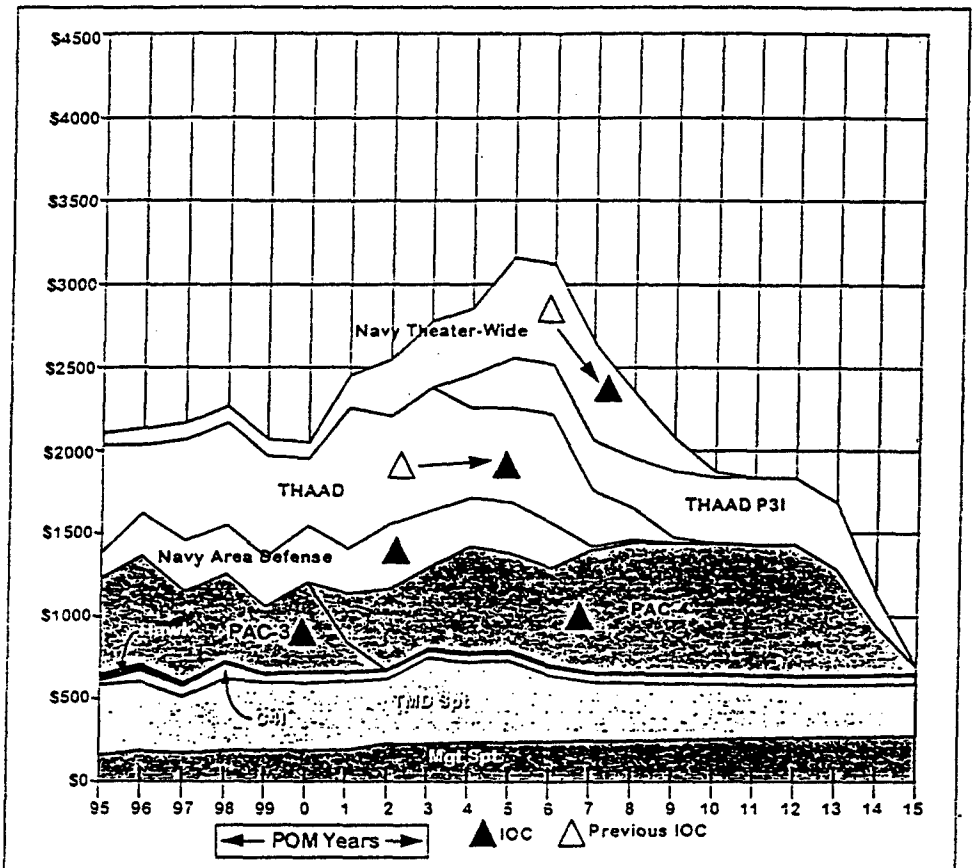


Figure C-17: Extended THAAD P3I/Enhanced Funding of PAC-4

- Option 3c (page C-10) plus additional PAC-4 funding (Option 3c with extended THAAD P3I substituted for THAAD and enhanced PAC-4 funding)
- Extend THAAD research and development two years
- Revise Navy Theater Wide (per recommended option)

APPENDIX D: INTERVIEWS

Mr. David M. Altwegg, Deputy Program Executive Officer, Theater Air Defense, Office of the Assistant Secretary of the Navy, (Research, Development and Acquisition) (DPEO/TAD), 5 October 1995.

MG Edward G. Anderson, III, U.S. Army, Assistant Deputy Chief of Staff for Operations and Plans, Force Development (ADCSOPS-FD), 2 October 1995.

CAPT James Barron, U.S. Navy, Program Manager, Navy Theater Ballistic Missile Defense, Office of the Program Executive Officer, Theater Air Defense, Assistant Secretary of the Navy, (Research, Development and Acquisition) (PEO-TAD/B), 5 October 1995.

Col Rodney L. Bates, U.S. Air Force, Director, Executive Agent for Theater Air Defense Battle Management, Command, Control, Communication, Computers and Intelligence, Office of the Director for Operational Requirements, Headquarters U.S. Air Force (HQUSAF/XORB), 21 September 1995.

BG Richard A. Black, U.S. Army, Program Executive Officer for Missile Defense, Office of the Assistant Secretary of the Army, (Research, Development and Acquisition) (PEO-MD), 4 October 1995.

COL Dennis D. Cavin, U.S. Army, Chief, Air and Missile Defense Division, Office of the Assistant Deputy Chief of Staff for Operations and Plans, Force Development (ODCSOPS/FDE), 22 September 1995 and 5 October 1995.

Mr. Edward L. Donalson, Principle Action Officer for Navy Theater Ballistic Missile Defense and Cooperative Engagement Capability, Office of the Assistant Secretary of the Navy, (Research, Development and Acquisition), 21 September 1995.

COL John P. Floris, U.S. Army, Chief, Concepts, Doctrine and Force Policy Division, Office of the Assistant Deputy Chief of Staff for Operations and Plans, Force Development (ODCSOPS/FDQ), 22 September 1995 and 5 October 1995.

Col Bruce D. Gillett, U.S. Air Force, Chief, Theater Air Defense Requirements, Director Operational Requirements, Office of the Deputy Chief of Staff for Plans and Operations (AF-XORT), 22 September 1995.

COL Joseph G. Girlando, U.S. Army, Executive Assistant to the Deputy Director, Missile Warfare, Office of the Under Secretary of Defense (Acquisition and Technology), Strategic and Tactical Systems (OUSD(A&T)/S&TS/MW), 2 October 1995.

COL Alan R. Hammond, U.S. Army, Director, Washington Operations, Program Executive Officer for Missile Defense, Office of the Assistant Secretary of the Army, (Research, Development and Acquisition) (PEO-MD), 4 October 1995.

CDR Joseph Horn, U.S. Navy, Navy Theater Ballistic Missile Defense Action Officer, Office of the Director, Theater Air Defense, Surface Warfare Division, Deputy Chief of Naval Operation (Resources, Warfare Requirements and Assessments) (OPNAV (N865J2)), 28 September 1995.

CAPT Anthony J. Kopacz, U.S. Navy, Director, Simulations, Technical Operations and Policy Division, Office of the Director for Force Structure, Resources and Requirements, Joint Chiefs of Staff (OJCS/J8), 30 August 1995.

Mr. Glenn Lamartin, Deputy Director, Missile Warfare, Office of the Under Secretary of Defense (Acquisition and Technology), Strategic and Tactical Systems (OUSD(A&T)/S&TS/MW), 2 October 1995.

Dr. Emmet H. Madry, Chairman, Operational Effectiveness Panel, Navy Theater Missile Defense Cost and Operational Effectiveness Assessment Study, Naval Surface Warfare Center Dahlgren Division, 2 November 1995.

Mr. Tom McCants, Deputy Director, Navy Theater Missile Defense Cost and Operational Effectiveness Assessment Study, and Principle Investigator, Navy Theater Missile Defense Lethality Assessment Special Study, Naval Surface Warfare Center Dahlgren Division, 2 November 1995.

RADM Wayne E. Meyer, U.S. Navy (Retired), President, W. E. Meyer Corporation, Inc., 17 October 1995 and 5 January 1996.

Dr. Bruce Pierce, Principal Deputy, Acquisition and Theater Missile Defense Deputate, Ballistic Missile Defense Organization (BMDO/DAQ), 21 August 1995 and 22 January 1996.

RADM Rodney P. Rempt, U.S. Navy, Director, Theater Air Defense, Surface Warfare Division, Office of the Deputy Chief of Naval Operation (Resources, Warfare Requirements and Assessments) (OPNAV (N865)), 29 September 1995 and 17 October 1995.

Col Richard Ritter, U.S. Air Force, Director, System Integration/Battle Management, Command, Control, Communications and Intelligence Directorate, Acquisition/Theater Missile Defense Deputate, Ballistic Missile Defense Organization (BMDO/AQI), 4 October 1995.

Mr. Stephen L. Schilling, Deputy Program Manager, Navy Theater Ballistic Missile Defense. Office of the Program Executive Officer, Theater Air Defense, Assistant Secretary of the Navy, (Research, Development and Acquisition) (PEO-TAD/B), 5 October 1995.

MGen Thomas W. West, U.S. Air Force, Special Assistant for Theater Air Defense, Office of the Chief of Staff, U.S. Air Force (HQUSAF/TA), 5 October 1995.

RADM Richard D. West, U.S. Navy, Deputy Director for Acquisition and Theater Missile Defense, Ballistic Missile Defense Organization (BMDO/AQ), 21 August 1995 and 22 January 1996.

APPENDIX E: ANNOTATED BIBLIOGRAPHY

Contents

NOTE: Classified references are indicated by an asterisk (*).
Restricted distribution references are indicated by a double asterisk (**).

BRIEFINGS

1. **"Why Army Theater Missile Defense (TMD)?"** Space and Strategic Defense Command (SSDC), circa March 1993.

   Develops the case for the Army TMD mission and capabilities by providing the historical context of TMD, the capabilities and maturity of Army systems, and a discussion of the other Service's system capabilities in the light of their ability to contribute to overall mission accomplishment.

   Key Words: **TMD, OSD, JCS, USA, USN, USAF, USMC, SSDC, BRIEFING**

2. **Joint Tactical Ground Station (JTAGS),** 12 August 1993.

   Briefing provides an overview of the program.

   Key Words: **JTAGS, USA, PEO-MD, USN, BRIEFING**

3. **Navy Theater Ballistic Missile Defense (TBMD),** undated (circa 27 January 1994).

   Briefing prepared by Hughes Aircraft Corporation, presents the rationale for "Why Sea-Based TBMD?" and information related to a "Navy Upper-Tier TBMD Trade Study." looking at Standard Missile-2 (SM-2) and Theater High Altitude Air Defense (THAAD) missile variants.

   Key Words: **NTW, HUGHES, BRIEFING**

4. Navy Command Systems Overview, 30 March 1994.

   Briefing presented to the Ballistic Missile Defense Organization (BMDO) by RADM (Sel) J. A. Gauss, USN, Space and Naval Warfare Systems Command (SPAWAR), presents the Navy strategy for fielding integrated command support systems, and discusses the relationship to joint Command, Control, Communications, Computers, and Intelligence (C4I) (includes Global Command and Control System (GCCS) and Theater Air Defense Battle Management, Command, Control, Communications, and Intelligence (BMC3I)).

   Key Words: **NCCS, USN, SPAWAR, BRIEFING**

5. **Aegis Computer Programs,** undated (circa June 1994).

   Briefing presented to BMDO by the Naval Surface Warfare Center Dahlgren Division (NSWC/DD), provides a description of the Aegis combat system, an

overview of the Aegis computer programs and their development, and a review of the success factors involved in the development of Aegis.

Key Words: **AEGIS, SPY-1, USN, BRIEFING**

6. **Theater Defense Netting Study (TDNS)**, undated (circa July 1994).

   Briefing and summary material outlines the purpose and preliminary results of the study.

   Key Words: **C2, TDNS, BMDO, OSD, STUDY, BRIEFING**

7. **Army Tactical Exploitation of National Capabilities (TENCAP) into the 21st Century . . . Bringing Space to Ground Maneuver**, undated (circa September 1994).

   Briefing prepared by the Army Space Program Office, provides a full scope overview of the programs currently part of the TENCAP family.

   Key Words: **USA, TENCAP, ASPO, BRIEFING**

8. **Cooperative Engagement Capability (CEC) in Air Defense Artillery**, undated (circa January 1995).

   Extract from a classified briefing prepared by the U. S. Army Air Defense Artillery School (USAADASCH), provides an assessment of CEC applications to Army air and missile defense systems.

   Key Words: **CEC, USA, BRIEFING**

9. **BMDO COEA Data Validation for the Airborne Interceptor (ABI) and the Airborne Laser (ABL)**, 10 March 1995.

   Briefing prepared by the United States Air Force Scientific Advisory Board (SAB), chaired by Dr. Gene H. McCall, provides an overview of the ABI and ABL weapons systems' potential contribution to the Boost-Phase Intercept (BPI) mission.

   Key Words: **COEA, ABI, ABL, USAF, BRIEFING**

10. **SAB Review of ABI** (forwarded to HQ USAF/TAD 31 March 1995, with distribution memorandum dated 3 April 1995), 10 March 1995.

    Report prepared by the USAF SAB ABI Missile Sub-Panel Chairman, Dr. L. F. Buchanan, provides a technical review of ABI performance parameters, submitted

in support of the BMDO TMD COEA; reviews the ABL program and was the basis for the 10 March 1995 ABI status briefing.

Key Words: **ABI, USAF, BMDO, COEA, BPI, ABL, REPORT**

11. **USAF SAB Review of ABI Status**, 10 March 1995.

Briefing prepared by the USAF SAB ABI Missile Sub-Panel (Dr. L. F. Buchanan, Mr. M. Fossier, and Mr. T. Wong) and presented to MGen West, USAF, Air Force Executive Agent for Theater Air Defense, reviews the ABI program.

Key Words: **ABI, USAF, BRIEFING**

12. ***Program Update Study (PROGRUS II) Final Report on National Missile Defense (NMD) (U)**, 30 March 1995.

Briefing prepared by the BMDO Systems Analysis Contractor (SAC), provides the current status and an assessment of the projected effectiveness of the NMD system, and provides detailed analysis of specific system capabilities and features.

Key Words: **NMD, PROGRUS, BMDO, STUDY, BRIEFING**

13. ***PROGRUS II/Summary Briefing on TMD (U)**, 14 April 1995.

Briefing prepared by the BMDO SAC and presented to LTG O'Neill, USA, Director BMDO, summarizes a study designed to support BMDO organizational testimony and serves as a pilot study and overview for the TMD COEA.

Key Words: **TMD, BMDO, PROGRUS, BRIEFING**

14. *TMD Program Update Study for 1995, TMD PROGRUS II 95 (U), 30 April 1995.

Collection of briefings prepared by the BMDO SAC and the Phase One Engineering Team (POET) staff and presented to the BMDO Architecture Integrator, reviews the BMDO programs in light of the events of the year; identifies potential issues for congressional testimony; and provides preliminary assessments of the pressing issues to be addressed in the TMD COEA.

Key Words: **PUR, BMDO, TMD, PROGRUS, STUDY, BRIEFING**

15. **Assessment of Navy Upper-Tier Roles, Capabilities, and Technical Solutions,** undated (circa 12 May 1995).

Briefing prepared for the U.S. Army Program Executive Officer for Missile Defense (PEO-MD), presents an alternative view of potential material alternatives to meet the Navy Upper-Tier or Theater Wide (NTW) operational requirement.

Key Words: **NTW, PEO-MD, USA, BRIEFING**

16. **CEC,** 22 June 1995.

Briefing presented to Mr. Peter Lennon, Staff, Senate Appropriations Committee, by Mr. Michael J. O'Driscoll, CEC Program Manager, provides an overview of the program, discusses some technical results of recent testing, and presents a current status of the program.

Key Words: **CEC, USN, C2, SENATE, BRIEFING**

17. ***Upper/Lower-Tier TBMD Systems Sensitivity Analysis (U),** undated (circa June 1995).

Selected extracts from a briefing prepared by the Johns Hopkins University/Applied Physics Laboratory, Mr. Alan Zimm, for the Assessment Division, Deputy Chief of Naval Operations (Resources, Warfare Requirements and Assessments) (N81), Office of the Chief of Naval Operations (OPNAV) and the Joint Chiefs of Staff (JCS), Director for Force Structure, Resources and Assessment (J8), studies impacts on port loading and tactical aircraft sortie rates caused by TBMD attacks.

Key Words: **UPPER, LOWER, USN, J8, ANALYSIS, BRIEFING**

18. **NMD - User Perspectives,** SSDC, 7 July 1995.

Provides a Ballistic Missile Defense (BMD) historical perspective, a status report on the NMD Technology Readiness Program, an overview of the United States Space Command (USSPACECOM) and United States Army Space Command (USARSPACECOM) NMD CONOPS, and a compendium of the USARSPACECOM FY 1995 tasks.

Key Words: **NMD, SSDC, USA, USARSPACECOM, CONOPS, BRIEFING**

19. **NMD Background,** 10 July 1995.

Briefing presented to the General Officer Steering Group (GOSG) by the PEO-MD, provides an NMD overview, the current status of the NMD Technology Readiness

Program, and a summary assessment of the impact of the pending FY 1996 congressional language.

Key Words: NMD, GOSG, USA, PEO-MD, BRIEFING

.0. **NMD Briefing,** 21 July 1995.

Presentation given by the PEO-MD to the Assistant Secretary of the Army for Research, Development and Acquisition (ASA (RDA)), requests support and decisions on resolving issues in order to ensure effective execution of the NMD program. Issues included the Ground-Based Interceptor booster, the management organization, and the need for a single management funding agreement (Program Management Agreement).

Key Words: NMD, USA, PEO-MD, BRIEFING

.1. **CEC Program Review,** 26-28 July 1995.

Consolidated briefing materials from the subject program review.

Key Words: CEC, USN, C2, BRIEFING

.2. **Army NMD Strategy,** 28 July 1995.

Draft briefing provides the near-, mid- , and long-term vision and top-level Army Staff guidance/management methodology for development and deployment of the NMD system as envisioned by the pending defense authorization and appropriations legislation.

Key Words: NMD, USA, BRIEFING

3. ***Impacts of Treaty Compliance and International Agreements on TMD and NMD (U),** 9 August 1995.

Briefing presented by MAJ(P) Pete DeRobertis, USA, Office of the Under Secretary of Defense, Strategic and Tactical Systems, Arms Control Intelligence and Compliance (OUSD/S&TS/ACI&C), provides an overview of treaty compliance activities, past, present, and future.

Key Words: TMD, NMD, TREATY, OSD, BMDO, BRIEFING

24. ***TMD and NMD Requirements (U)**, 9 August 1995.

Briefing prepared by the JCS (J8), provides background information on the development of BMD requirements, the approved Capstone ORD Key Parameters, the current status of ORD development, and the JCS TMD prioritization.

Key Words: **TMD, NMD, BRIEFING**

25. **Kick-off Meeting for the BMD Review Steering and Working Groups on August 24**, undated (circa 23 August 1995).

Memorandum schedules the subject meeting. Includes the Under Secretary of Defense, Acquisition and Technology (USD (A&T)) letter of direction, **BMD Review** with Draft Terms of Reference for the review, and a **BMDO TMD Bottom-Up Review (BUR) - "The Way Ahead"** briefing dated 22 August 1995 and 23 August 1995, respectively.

Key Words: **TMD, BUR, BMDO, OSD, BMD, MEMO, BRIEFING**

26. **BMD Review Kick-off Meeting**, 24 August 1995.

Briefing defines the purpose and scope of the review and the threat definition under which the review is to be conducted.

Key Words: **TMD, BUR, BMDO, OSD, BRIEFING**

27. **BMDO Program Update Review (PUR) Advisory Group Meeting**, 25 August 1995.

Briefing further defines the review scope and provides the schedule of the Working and Advisory Group meetings.

Key Words: **PUR, BMDO, OSD, BRIEFING**

28. **Joint TMD, Reducing the Number of Active Defense Systems.** 6 September 1995.

Briefing prepared for LTG Garner, USA, Commander, SSDC, to present to ADM Owens, USN, Chairman, Joint Requirements Oversight Council (JROC), presents a view of how scarce dollar resources might be reallocated among the TMD systems while maintaining a credible capability against the threat.

Key Words: **J8, JCS, SSDC, JROC, BRIEFING**

29. **Stinger Force Protection - Past, Present, And Future . . .**, undated (circa 6 September 1995).

Briefing prepared and presented by the Stinger Program Office to COL Michael Vane, Director of Combat Developments, USAADASCH, provides a general overview of the program and seeks support for the Stinger Block I and Block II missile procurements and developments.

Key Words: **STINGER, USA, BRIEFING**

30. **BMD Policy For BMD Program Review Meeting**, 8 September 1995.

Briefing prepared and presented by Dr. Frank Dellerman, Director, Strategy, Forces, and Operations, International Security Policy, Office of the Secretary of Defense (OSD), provides a summary of the current National and OSD policy position related to BMD.

Key Words: **PUR, BMDO, POLICY, BRIEFING**

31. **THAAD System Growth Options for Navy Upper-Tier Mission**, 8 September 1995.

Briefing prepared by SSDC, presents a strategy to capitalize on THAAD and Navy Upper-Tier commonality.

Key Words: **USN, THAAD, NTW, STUDY, BRIEFING**

32. ***Army TMD Strategy (U)**, 14 September 1995.

Briefing presented to the JCS (J8) Study Group by COL Cavin, USA, Office of the Deputy Chief of Staff for Operations, Director Force Development (DCSOPS (FDE)), provides an overview focus and vision for all Army Active TMD programs.

Key Words: **TMD, USA, BRIEFING**

33. ****Corps Surface to Air Missile (SAM) Briefing for the BMD Program Review**, 14 September 1995.

Briefing presented by the PEO-MD, provides the current development status of the Corps SAM System as a long term follow-on replacement for the Phased Array Tracking to Intercept of Target (Patriot) system. Also provides some insight into the NATO Medium Extended Air Defense System planning structure as a method of joint international development of the Corps SAM system.

Key Words: **CORPS SAM, BMDO, PUR, PEO-MD, BRIEFING**

34. **Patriot Status for the BMD Program Review**, 14 September 1995.

Briefing prepared and presented by the PEO-MD and the Patriot Program Manager, provides an overview of the program content and current status.

Key Words: **PATRIOT, PUR, BMDO, USA, PEO-MD, PAC-3, BRIEFING**

35. ****THAAD Program Overview**, 14 September 1995.

Briefing prepared and presented by COL W. Fredrick Kilgore, USA, THAAD Program Manager, to the BMD Program Review, provides a program update.

Key Words: **THAAD, PUR, USA, PEO-MD, BRIEFING**

36. **TMD COEA Update**, undated (circa 18 September 1995).

Briefing presented to GEN Dennis J. Reimer, USA, Chief of Staff, provides an overview of the COEA organization, and identifies and updates the Army's COEA concerns and issues.

Key Words: **TMD, BMDO, COEA, USA, BRIEFING**

37. ***Space Based Infra-Red System (SBIRS)/Space and Missile Tracking System (SMTS) Overview (U)**, 19 September 1995.

Briefing provides an SBIRS program overview and explains the relationship of SMTS to the program.

Key Words: **SMTS, USA, NMD, SBIRS, BRIEFING**

38. Capstone TBMD Active Defense ORD, 21 September 1995.

Briefing prepared and presented by CAPT John Langknecht, USN, Director, BMDO Joint Forces Directorate, to BG Robert R. Hicks, Jr., USA, JCS-DJ8, presents the BMDO view of a Capstone ORD for TBMD.

Key Words: **ORD, BMDO, TBMD, CAPSTONE, JCS, J8, BRIEFING**

39. ***Navy TBMD Overview (U)**, 29 September 1995.

Briefing presented by RADM Rodney Rempt, USN, OPNAV, Director for Theater Air Defense (N865), to the JCS (J8) Study Group, provides the Navy view of the

contribution that a sea-based TBMD capability would make to the U.S. joint warfighting capability.

Key Words: **NTBMD, NTW, NAD, USN, OPNAV, BRIEFING**

40. **TMD Command, Control and Communications (C3) Program Overview,** September 1995.

Briefing presented to the JCS (J8) TMD Study Group by COL Richard Ritter, USAF, BMDO, Director, Systems Integration and Battle Management, Command, Control and Communications, provides a top-level view of the proposed TMD C3 architecture and an update of issues, status, and future plans.

Key Words: **TMD, C2, BMDO, BRIEFING**

41. **NMD Alternatives, BMD Program Review Working Group,** 16 October 1995.

Briefing provided by the BMDO, outlines thirteen possible development and deployment scenarios associated with the NMD Technology Readiness Program and Contingency Deployment Program.

Key Words: **NMD, BMDO, PUR, BRIEFING**

42. **Technology Subgroup Report,** 16 October 1995.

Briefing presented by COL Dayton Silver, Deputy for ICBM Systems. USD (A&T)/S&TS (Missile Warfare (MW)). provides an overview of the ongoing Advanced Technology programs and lays out funding and priority alternatives for those programs.

Key Words: **PUR, BMDO, TECHNOLOGY, OSD, BRIEFING**

43. ***Army Complementary Study to the TMD COEA (Phase I) (U),** 17 October 1995.

Briefing prepared by SSDC. presents the full draft report of a study effort requested by BMDO of the Services to help "fill in the blanks" and augment the BMDO COEA effort. This study checked system representations. provided additional analysis of results. and ran Army proposed excursions to complete the story and supported Army COEA panel representatives.

Key Words: **USA, TMD, COEA, STUDY, BRIEFING**

44. ***CEC, Leading the Revolution (U),** 17 October 1995.

Briefing presented to the JCS (J8) Study Group by RADM Rodney Rempt, USN, OPNAV (N865), provides a system overview, and current program content and status.

Key Words: **CEC, USN, OPNAV, BRIEFING**

45. ***Naval TBMD (U),** 17 October 1995.

Follow-on briefing presented by RADM Rodney Rempt, USN, OPNAV (N865), to the JCS (J8) Study Group, provides expanded details of the rationale for Navy TBMD, specifics on the current Navy program, details of recent accomplishments, a discussion of the Navy role in joint Operations, and some perspectives on TMD in general.

Key Words: **NTBMD, NTW, NAD, USN, OPNAV, BRIEFING**

46. ***Army Complementary Study to the TMD COEA (Phase I) (U),** 18 October 1995.

Briefing prepared by SSDC, presents a draft executive summary of a study effort requested by BMDO of the Services to help "fill in the blanks" and augment the BMDO COEA effort. The study checked system representations, provided additional analysis of results, and ran Army proposed excursions to complete the story and supported Army COEA panel representatives.

Key Words: **USA, TMD, COEA, STUDY, BRIEFING**

47. *Joint Theater Missile Defense Review (JTMD) (U), undated (circa 19 October 1995).

Briefing presented by the JCS (J8) Senior Study Group to the JCS (J8), presents an interim progress report on the review.

Key Words: TMD, J8, JCS, BRIEFING

48. Naval Missile Defense—Forward . . . From the Sea, NMD, undated (circa 20 October 1995).

Briefing prepared by CDR Daniel Morgavich, USN, OPNAV (N865A), in response to a congressional query asking how the Navy could develop the Navy Theater

Wide system for the NMD mission, and what the most aggressive acquisition profile might be.

Key Words: NMD, NTW, USN, CONGRESS, OPNAV, BRIEFING

49. **Cruise Missile Defense (CMD) and TMD, GOSG Review, 26 October 1995.**

Briefing reports on the status of OSD/JCS taskings, reviews, and Army TMD/CMD Programs. Designed to assist the GOSG in achieving a common vision for Fall 1995 activities leading to the FY 1997 Budget Estimate Submission and to lay the groundwork for the Program Objectives Memorandum FY 1998-2003 build.

Key Words: CMD, TMD, GOSG, USA, BRIEFING

50. ***JTMD Review (U), 26 October 1995.**

Briefing report presented by the JCS (J8) Senior Study Group to the JROC, presents the final results and recommendations of the review.

Key Words: TMD, JCS, J8, JROC, STUDY, BRIEFING

51. Aerostat-Based Support of CMD, 30 October 1995.

Briefing presented to the Honorable Dr. Kaminski, (USD (A&T)), by Mr. Jess Granone. SSDC. provides information on the scope and status of an aerostat demonstration program and includes information on development of a CONOPS, programmatics, and management structure.

Key Words: AEROSTAT, CMD, USA, BRIEFING

52. *Joint Warfighting Capability Assessment (JWCA) -- TMD Attack Operations (U), undated (circa October 1995).

Briefing prepared by the JCS (J8) Joint Warfare Assessment Division. LCDR Phil Pardue. USN. presents the results of the assessment conducted with the assistance of six JWCA teams (Command and Control (C2). ISR. Strike, Air Superiority. Ground Maneuver. and Counter Proliferation).

Key Words: JWAD, JCS. TMD, ATTACK. BRIEFING

53. *Past and On-Going Attack Operations Analysis (U), undated (circa October 1995).

Briefing prepared by SSDC. presents a compendium of material from the Field Artillery Attack Operations Study and Army Attack Operations Requirements

Study, the TMD Integration Study, and the Preliminary Attack Operations Analysis for the TMD COEA.

Key Words: **ATTACK, USA, COEA, SSDC, BRIEFING**

54. ***BPI Concept Assessment, Independent Working Group Final Report (Briefing) (U)**, 9 November 1995.

Briefing presented by Glenn F. Lamartin, OUSD (A&T), Deputy Director, S&TS (MW)), reports the results of the study.

Key Words: **BPI, OSD, ASSESSMENT, BRIEFING**

55. **Army Attack Operations Analysis Supporting the BMDO TMD COEA,** undated (circa 10 November 1995).

Briefing (extract) prepared by SSDC, presents the results of an analysis which developed quantified Army attack operations benefits for use in the BMDO TMD COEA. The analysis integrates the effect of sensors and weapons against the threat to produce transporter erector launcher and theater ballistic missile kills, and integrates attack operations effects to quantify campaign-level benefits.

Key Words: **ATTACK, COEA, USA, BRIEFING**

COST ANALYSIS REQUIREMENTS DESCRIPTIONS (CARD)

56. **Sea-Based Area (or Navy Area Defense (NAD)) TBMD CARD (Rev. 1) (DRAFT)**. 29 April 1994.

Provides a comprehensive description of the Navy Area TBMD program.

Key Words: **USN, NAD, CARD**

57. *Navy Area TBMD CARD (Rev. 2) Appendix 3, Systems Characteristics and Performance Parameters (Draft) (U), 29 March 1995.

Provides a detailed description of the Navy Area TBMD program classified system characteristics and performance parameters.

Key Words: **USN, CARD, NAD**

58. ***Navy Theater Wide TBMD CARD (Rev. PD 0.2), Appendix B, System Characteristics and Performance Parameters (Preliminary Draft) (U),** 7 June 1995.

Provides a detailed description of the Navy Theater Wide TBMD program classified system characteristics and performance parameters.

Key Words: **USN, CARD, NTW,**

COST AND OPERATIONAL EFFECTIVENESS ANALYSES (COEA)

59. ***Corps SAM COEA - Executive Summary (U), June 1993.**

Prepared and certified by the Commander, U.S. Army Training and Doctrine Analysis Command, Study and Analysis Center, provides a basis for comparing alternative systems for performing low-to-medium altitude air defense for maneuver forces and high-priority assets against a wide variety of fixed-wing, rotary-wing, unmanned aerial vehicles, cruise missiles, tactical air-to-surface missiles, and short-range ballistic missile threats.

Key Words: **COEA, CORPS SAM, USA**

60. **Guidance for the Milestone II/IV COEA Study for Sea-Based TBMD Systems** (Upper/Lower-Tier), 12 May 1994, 24 June 1994, and 18 July 1994, respectively.

Provides three successive draft versions, dated as above, of the guidance for the conduct of Navy TBMD COEA.

Key Words: **COEA, USN, UPPER, LOWER, NTW, NAD, DAB, OSD, SEA BASED**

61. ***Overview and Summary of Preliminary Findings for TMD Capstone COEA** (U), 11 September 1995.

Prepared by the BMDO SAC, the briefing sets the stage for the next four weeks, the time remaining until completion of Phase I of the COEA; presents a summary of the Capstone COEA purpose, assumptions and constraints; and summarizes the preliminary findings.

Key Words: **COEA, BMDO, TMD, CAPSTONE, OSD, USA, USN, USAF**

62. ***Summary of Phase I Findings for TMD Capstone COEA, Phase I Technical Briefing (Annotated DRAFT),** dated 21 November 1995.

Prepared by the BMDO SAC, the briefing focuses on the major findings; provides a performance assessment of the baseline and alternative architectures; shows details regarding the special studies on BMC4I, sensor fusion, and attack operations; and discusses and summarizes the cost of the various systems.

Key Words: **COEA, BMDO, TMD, CAPSTONE, OSD, USA, USN, USAF**

63. ***Summary of Phase I Findings for TMD Capstone COEA, Phase I Executive Briefing, (Annotated DRAFT),** dated 21 November 1995.

Prepared by the BMDO SAC, the briefing is a summary of the Phase I TMD COEA and focuses on the major findings, resulting implications, and concluding comments.

Key Words: **COEA, BMDO, TMD, CAPSTONE, OSD, USA, USN, USAF**

CONCEPTS OF OPERATIONS (CONOPS)

64. ***CONOPS for the JTAGS (U).** 15 August 1994.

Draft, jointly prepared by the USARSPACECOM and U.S. Navy Space Command (NAVSPACECOM), provides ground, naval, air, and joint supporting and supported forces with information to support the effective operational employment of the JTAGS.

Key Words: CONOPS, USA, JTAGS, USARSPACECOM, NAVSPACECOM

65. **Air Force TMD Concept of Operations,** 24 February 1993.

Approved by the Commander, Air Combat Command; Commander United States Air Force Space Command (USAFSPACECOM); and the Chief of Staff, USAF; the document describes general Air Force operational capabilities and processes that contribute to joint operations required to defeat the theater missile threat in future conflicts. The document should serve as a USAF guide for more detailed planning in developing joint doctrinal and operational documents. From an Air Force perspective it will ensure compatibility and interoperability of multi-service C4I nodes and identify phased improvements to C4I, sensors, and weapons systems supporting TMD operations.

Key Words: CONOPS, USAF, TMD

66. ****Army Air Defense Artillery Operational Concept for TBMD,** 9 April 1993.

Approved by the Commandant, USAADASCH, the document describes the USAADASCH's concept for employment of THAAD and Patriot Advanced Capability-3 (PAC-3) integrated to provide a united defense against tactical missiles. While the focus is on systems available in 2001, this document will also serve as an interim concept of operations for Army TMD providing the conceptual basis for task force interoperability when the THAAD User Operational Evaluation System (UOES) is fielded with Patriot.

Key Words: **CONOPS, USA, TMD, THAAD, PATRIOT, PEO-MD, UOES**

67. ***United States Central Command (USCENTCOM) Functional Architecture for JTMD, Concept Draft and USCENTCOM Tactics, Techniques, and Procedures for TMD (U), Annexes A through F,** 19 March 1993 (UNCLASSIFIED) and 23 June 1993 (SECRET/NOFORN).

Sets forth the functions, organization, and systems used to conduct JTMD activities of USCENTCOM.

Key Words: **TTP, TMD, CENTCOM, CONOPS**

68. ***Navy CONOPS for TBMD (U),** July 1993.

Prepared for the Anti-Tactical Ballistic Missile Program Office, NSWC/DD, describes the TBMD concepts of operations that will be employed by Navy TBMD units engaged in combat operations in the year 2000+ and focuses on "active missile defense" functions of TMD as defined by the JCS.

Key Words: **CONOPS, USN, NTW, NAD**

69. ***CONOPS for the Brilliant Eyes (BE) Satellite System, Draft (U),** 1 October 1993.

Prepared by HQ USAFSPACECOM/DOP, the document describes the approach towards the operations of the BE system. The CONOPS defines the operation of the BE system to include its operating environment, mission, systems, employment, security, safety, logistics, and system future.

Key Words: **CONOPS, BE, USAF, NMD, TMD**

70. ***USSPACECOM BMD CONOPS (Support to Theater BMD) (U), Vol. I,** 20 December 1993.

Describes the major elements and concepts necessary for the United States

Commander in Chief, Space (USCINCSPACE) to provide support to forces deployed in overseas theaters of operations.

Key Words: **NORAD, USSPACECOM, TMD, CONOPS, BMD, USN, USA, USAF, USMC, PEO-MD, SSDC**

71. ***North American Defense Command (NORAD)/USSPACECOM BMD CONOPS (North American BMD) (U), Vol. II,** 20 December 1993.

Describes the major elements and concepts necessary for CINCNORAD to protect parts of North America against limited or accidental ballistic missile attack.

Key Words: **NORAD, USSPACECOM, BMD, CONOPS, NMD**

72. ****Army Operational Concept for a JTAGS,** 30 January 1995.

Coordinating draft prepared by USAADASCH and approved by MG James J. Cravens, Jr., USA, Commandant, USAADASCH, describes general operational capabilities and clarifies other key areas such as dissemination architecture, organizational plans, training concepts, and logistic concepts. It establishes the basis for system-specific operational requirements, system development, system integration, and the more detailed planning of doctrine and concepts of operations for deployment/employment of JTAGS in theater.

Key Words: **CONOPS, USA, JTAGS, USAADASCH**

73. **JTMD CONOPS,** 17 February 1995.

Prepared by the JCS (J-36), the document provides a baseline reference for planning joint TMD operations. It is not a Chairman, Joint Chiefs of Staff (CJCS) approved document and has not been formally coordinated. This CONOPS builds on the foundation in JCS doctrine (JCS Pub 3-01.5), amplifying TMD planning and operational guidance. The main purpose of the CONOPS is to highlight issues which should be considered by the Joint Force Commander when preparing a TMD plan or executing TMD operations. It is designed to assist a planner or operator in thinking through TMD options and facilitating the decision making process.

Key Words: **CONOPS, TMD, JOINT, JCS**

JOINT PUBLICATIONS

74. **Doctrine for JTMD, Joint Pub 3-01.5,** 30 March 1994.

Sets forth doctrine for the integration of TMD capabilities to support execution of the Joint Force Commander's operation or campaign plan.

Key Words: **JTMD, DOCTRINE, CONOPS, REFERENCE**

75. **Doctrine for Joint Operations, Joint Pub 3-0,** 1 February 1995.

Sets forth doctrine to govern the joint activities and performance of the Armed Forces of the U.S. in joint operations, as well as the doctrinal basis for U.S. military involvement in multinational and interagency operations; provides military guidance for the exercise of authority by combatant commanders and other joint force commanders; prescribes doctrine for joint operations and training; and provides military guidance for use by the Armed Forces in preparing their appropriate plans.

Key Words: **JOINT OPERATIONS, DOCTRINE, CONOPS, REFERENCE**

MEMORANDA AND LETTERS

76. **TBMD,** 4 June 1992.

Memorandum from the Secretary of the Navy (SECNAV) to the Chief of Naval Operations (CNO) and the Assistant Secretary of the Navy (Research, Development and Acquisition) (ASN (RDA)), provides direction and specific guidance on acceleration of the effort to allow the Navy to take full advantage of the Congressional and OSD support for the Navy's participation in the TBMD mission.

Key Words: **TBMD, USN, OSD, NTW, NAD, C2, SM-2, SPY-1, TMD, BMDO, MEMO**

77. **BPI Advanced Concept Technology Demonstration (ACTD),** 18 March 1994.

Memorandum from the JCS (J-7) to the Deputy Under Secretary of Defense for Advanced Technology, reaffirms the JCS support of the BUR Core Programs decision and supports a BMDO BPI ACTD.

Key Words: **JCS, USA, USN, ACTD, BUR, BMDO, BPI, MEMO**

78. **Agreements Regarding Approach to the Defense Acquisition Board (DAB) Review of Navy TBMD,** 7 June 1994.

Memorandum for the Record signed by ASN (RDA), USD (A&T/S&TS), Director BMDO, and USD (A&T/Deputy TWP-NW), summarizes the agreements made leading to a Navy TBMD DAB review to be held not later than July 1994.

Key Words: **DAB, USN, TBMD, NTW, NAD, BMDO, OSD, MEMO**

79. **Navy TBMD,** 14 June 1994.

Memorandum from the CNO to the Vice Chief of Naval Operations (VCNO), directs the establishment and staffing of a single office within the Navy responsible for all TBMD requirements and policy, and provides additional Navy staff to the BMDO.

Key Words: **USN, TBMD, BMDO, TMD, MEMO**

80. **Navy TBMD Milestone Documentation Plan,** 23 June 1994.

Briefing prepared by SPA. Inc., presents the background and tools needed to prepare the documentation required to support the Milestone IV DAB scheduled for December 1995.

Key Words: **USN, NTW, NAD, DAB, BMDO, OSD, BRIEFING**

81. **Navy Theater Ballistic Missile (TBM) Area Defense,** 5 July 1994.

Memorandum from the CNO and the Commandant of the Marine Corps (CMC) to the CJCS. establishes the first priority of the Navy and Marine Corps in TMD to be the rapid fielding of the Navy Area TBMD system.

Key Words: **USN, JCS, NAD, TBMD, TMD, USMC, MEMO**

82. **Strategic Systems Committee (SSC) Action Officers Planning Meeting for the DAB Review of Navy TBMD,** 8 July 1994.

Memorandum for USD (A&T). reports the results of the subject meeting at which the group discussed the context and process leading to a July 1994 DAB. reviewed the Navy's current activities and future plans. and raised issues to be resolved.

Key Words: **OSD, DAB, USN, TBMD, BMDO, NTW, NAD, MEMO**

SSC Review of Navy Area TBMD, 29 July 1994.

Memorandum for the USD (A&T), reports the results of the subject review leading to an August 1994 DAB. This memo lists agreements reached to resolve OSD staff concerns; the top-level exit criteria to be defined, which will measure the readiness of the Navy for a Milestone IV review in December 1995; the documentation that will be submitted for the Milestone IV review; open issues with assigned action agencies and due dates; and other action items with longer term suspenses.

Key Words: **TBMD, USN, DAB, OSD, BMDO, NTW, NAD, PEO-TAD, MEMO**

Navy TBM Area Defense, 10 August 1994.

Memorandum from the CJCS to the CNO and the CMC, restates the JCS support of the Navy Sea-Based Area TBMD program.

Key Words: **USN, JCS, NAD, USMC, TBMD, TMD, MEMO**

Navy Area TBMD Acquisition Decision Memorandum, 24 August 1994.

Memorandum for SECNAV, BMDO, and OSD Program Analyses and Evaluation, approves the Milestone IV risk reduction exit criteria and documentation requirements, approves the development testing/UOES missile strategy, directs the development of COEA guidance, requires plans to address UOES and engineering and manufacturing development threat-representative testing, requires assessment of SM-2 lethality against the full spectrum of threats and warheads with priced improvement plans including hit-to-kill lethality levels if needed, and presents other related acquisition plans/alternatives.

Key Words: USN, DAB, ADM, TBMD, NTW, NAD, BMDO, OSD, MEMO

Letter/Memo to the Honorable Strom Thurmond, Chairman, Committee on Armed Services, United States Senate, from CJCS, 5 July 1995.

Responds to language in the Conference Report accompanying the National Defense Authorization Act for Fiscal Year 1995 providing information on the lethality analysis, capability, and preplanned product improvements for the Navy SM-2 Block IVA missile.

Key Words: CONGRESS, SENATE, CJCS, USN, SM2, LETHALITY, MEMO, LETTER

MISSION NEED STATEMENT

87. **TMD Mission Need Statement (MNS), JROC Memorandum (JROCM)-064-91,** 18 November 1991.

Memorandum provides requirements for a theater missile defense against ballistic missiles, cruise missiles, or air-to-surface guided missiles whose target is within a theater or which is capable of attacking targets in a theater.

Key Words: **TMD, MNS, JCS, ROC, BMDO, USA, USN, USAF, USMC**

OPERATIONAL REQUIREMENTS DOCUMENTS (ORD)

88. **ORD for High Altitude Theater Missile Defense (HATMD) (U),** approved 22 January 1992, distributed 2 March 1992.

Approved by the Army, provides the requirements for a system that will defeat missile threats directed against military forces, critical assets, and theater-strategic assets such as population centers and industrial resources.

Key Words: ORD, HATMD, USA, SSDC, PEO-MD

89. ***Revised ORD for TMD Space-Based Warning (U),** 17 August 1992.

Prepared by USAFSPACECOM, provides draft requirements for a prototype/demonstration system to provide timely, high confidence, accurate warning and cueing information from space-based warning systems to assets involved in the active defense, attack operations, and passive defense functions.

Key Words: USAFSPACECOM, ORD, TMD, USAF, WARNING, TWAA

90. ***ORD for Aegis Near-Term TBMD (U) and SM-2 Block IVA (U),** approved 30 December 1992 and 20 December 1992, respectively.

Approved by the Navy, provides requirements for the modification of the Aegis Combat System necessary to provide an integrated and robust near-term endoatmospheric capability against TBMs, and the requirements for a product improvement to the SM-2 Block IV Extended Range baseline missile to provide the Block IVA missile with a TBMD capability while retaining current Block IV Anti-Air Warfare (AAW) capability.

Key Words: TBMD, AEGIS, ORD, SM2, NAD, OPNAV, USN, BMDO

***Draft ORD for the BE System (U), 13 July 1993.**

Prepared by USAFSPACECOM, provides the requirements for the space surveillance element of NMD in support of the Capstone BMD ORD.

Key Words: **USAFSPACECOM, BE, ORD, USAF, USA, USN, NMD, TMD, BMDO, SMTS, SBIRS, JROC**

***Army ORD for the JTAGS, Final Draft, Rev 1 (U), 27 July 1993.**

Prepared by USAADASCH/DCD, provides requirements for a strategically deployable and tactical capability to receive and process space-based sensor information on TBMs and other items of interest in order to provide near-real-time warning, cueing and targeting data for direct and indirect dissemination to in-theater tactical forces and population centers.

Key Words: **ORD, USA, JTAGS, C2, BMDO**

***ORD for the Corps SAM System (U), 1 September 1993.**

Approved by the Army on 5 October 1993. provides the requirements for a system that will counter/defeat/destroy theater missiles (TMs), unmanned air vehicles, and air breathing threats (ABTs) primarily targeted against a U.S. Army Corps and operating behind, above, and beyond forward area air defenses, and will complement other service counter air systems as well as other Army TMD systems.

Key Words: **ORD, CORPS SAM, USA, SSDC, PEO-MD**

***ORD for PAC-3 (U), 1 May 1992 (Version 1.4), revised 8 December 1993.**

Approved by the Army. states requirements for a major upgrade to the Patriot system to counter/defeat/destroy the current and evolving fixed wing ABT and theater missile third-dimension threat as a part of an integrated family of weapons.

Key Words: **PAC-3. ORD, TMD, BMDO, USA, PEO-MD, SSDC, ERINT**

***Final ORD for TMD Air-Launched Ascent/Boost-Phase Intercept (U), 20 January 1994.**

Prepared and approved by the Commander. Air Combat Command. provides the requirements for a near- to mid-term air-launched kinetic energy interceptor weapon system fully integrated into the theater battle management architecture and

capable of negating (from standoff distances) theater ballistic missiles during the boost and ascent phase of flight.

Key Words: **ORD, USAF, API, BPI, TMD, BMDO**

96. ***Army comments on and mark-up of the Final ORD for TMD Air-Launched Ascent/Boost-Phase Intercept (U)**, 20 January 1994.

Recommends that the Army non-concur with the ORD due to shortcomings in integrating the TMD requirements of future Army systems already well into the development process (PAC-3, THAAD, etc.), and the lack of analysis on the proposed system effectiveness in light of platform (airplane) requirements and the vulnerability of the launch platform to threat systems.

Key Words: **ORD, USA, USAF, API, BPI, TMD, BMDO**

97. ***ORD for SM-2, Block IV (U)**, 16 February 1994.

Distributed by the JROC, provides requirements for the continued evolution of the Standard Missile to counter the evolving threat from Anti-Ship Cruise Missiles (ASCMs) and ASCM launch aircraft by upgrading the SM-2 Block IIIA Medium Range baseline to increase kill probabilities in stressful scenarios and expand the AAW battle space. Also provides the baseline and framework for the Navy's TBMD Program.

Key Words: **SM2, ORD, NAD, OPNAV, USN**

98. ***Capstone ORD for BMD (U)**, 9 December 1994.

Prepared/approved by USSPACECOM and validated by the JROC. provides requirements for an objective BMD System which will provide protection from ballistic missile attack for U.S. and/or coalition forces deployed in overseas theaters and defend the continental United States against limited ballistic missile attacks from longer range missiles.

Key Words: **ORD, BMD, CAPSTONE, USSPACECOM**

99. ***Supporting Rationale for the Capstone BMD ORD (U)**, 9 December 1994.

Prepared by USSPACECOM. provides users and developers with substantiation for each of the requirements defined in the Capstone BMD ORD.

Key Words: **ORD, BMD, USSPACECOM, CAPSTONE, RATIONALE**

100. ****ORD for the Three-Dimensional Long-Range Radar,** 21 December 1994.

Prepared by the U.S. Marine Corps, provides the requirements for a three-dimensional radar capable of detecting, identifying, tracking, and reporting on all aircraft and missiles within the Marine Air-Ground Task Force (MAGTF) area of responsibility by providing a real-time display of all air activity. The system must also be rugged enough to support a wide range of tactical operations in all types of weather and terrain conditions where the MAGTF might be deployed.

Key Words: **ORD, 3D RADAR, USMC, HAWK, TPS-59**

101. **Draft ORD for U.S. Army's TMD Force Projection Tactical Operations Center (TOC), Ver 4.01.,** 26 January 1995.

Prepared by USARSPACECOM, provides the requirements for a system that will provide the synchronization and integration structure to coordinate and fuse the functional elements of the TMD system to enhance the overall effectiveness of deployed tactical systems. When fielded, it will conduct, monitor, and display TMD force operations by providing a timely assessment of the threat, rapid dissemination of tactical warning, targeting data, and engagement/battle damage status assessments.

Key Words: **USARSPACECOM, ORD, TOC, USA, USAF, BMDO, C2**

102. ***Space-Based Infrared System (SBIRS) Capstone Requirements Document (U),** 31 January 1995.

Provides draft requirements to support integrated threat warning and attack assessment, provision of timely, accurate, and unambiguous missile warning and missile defense information through all stages of conflict; and support data gathering for assessment that will allow warfighters to accomplish their combatant roles and missions.

Key Words: **SBIRS, CAPSTONE, ORD, USAF, OSD**

103. *Draft BMD C3 ORD, (U), 28 April 1995.

Prepared by USAFSPACECOM, defines the C3 capabilities needed for assured human-in-control, centralized command and decentralized execution of strategic BMD forces and addresses the capabilities needed to ensure strategic BMD C3 system support, and to interoperate with theater command, control, communications, and intelligence missile defense forces and systems.

Key Words: **ORD, USAFSPACECOM, C3, NMD, BMD, C2, USAF, USA, USN**

104. ***THAAD ORD, Milestone 2, Version 3 (Worldwide Staffing),** dated 16 June 1995.

Provides the requirements for the THAAD component of Army air defense which will protect theater forces and critical assets from short and medium-range TBMs. This ORD will replace the Milestone I HATMD ORD when approved and validated for the THAAD Milestone II acquisition decision.

Key Words: **HATMD, THAAD, ORD, PEO-MD, USA, USARSPACECOM**

105. **Capstone BMD ORD, JROCM 121-95,** 27 September 1995.

JROC memorandum which requests CINCUSSPACECOM to continue to be the users' representative for both NMD and TMD programs, and develop an approach to expand the scope of the current Capstone BMD ORD. Additionally it requested development of a strategy to evolve the BMD ORD to best accommodate TMD and NMD "systems of systems" (i.e. Space-Based Infrared System) and address the following: overarching requirements for all TMD pillars; full theater missile threat and interoperability between TMD pillars; interoperability between TMD systems and NMD systems; incorporation of the latest STAR and available results of the ongoing TMD COEA effort; and in conjunction with the developer, establish a maturity matrix for the Capstone ORD requirements.

Key Words: **USSPACECOM, ORD, BMD, JROC, CAPSTONE, MEMO**

106. ***Navy TBMD ORD (U),** 24 August 1995.

Briefing presented by OPNAV (N865) to the BMDO PUR, provides a TMD MNS and Capstone ORD overview, and an explanation of the specific Navy TBMD requirements.

Key Words: **USN, ORD, TBMD, NAD, NTW, OPNAV, BMDO**

107. ***Navy TBMD ORD, Draft F (U),** 7 November 1995.

Prepared by OPNAV (N865), specifies requirements for naval systems which fit into a *family of systems* concept and contributes to the need to defend U.S. and allied forces against attack by TBMs.

Key Words: **NTBMD, USN, ORD, NTW, NAD, OPNAV, BMDO, TMD**

PAPERS

108. **BALLISTIC MISSILES -- The Approaching Threat, Bailrigg Memorandum 9**, Humphry Crum Ewing, Dr. Robin Ranger, David Bosdet, Centre for Defence and International Security Studies, copyright 1994.

Summarizes the most accurate, publicly available, information on all types of ballistic missiles that governments either currently possess or may be expected to possess within the next few years, and assesses the potential threats they could pose to British interests and the security of Britain itself. Through logical extension, much of this information can be extrapolated to other countries and areas of the world.

Key Words: **BMD, TMD, USA, USN, PAPER**

109. **Discussion of Marinized THAAD Issues**, 5 July 1995.

Point Paper prepared by CAPT John M. Kelly, USN, OPNAV (N865J), concludes that any decision on a *common* missile based on THAAD should be deferred until completion of the Navy COEA on Navy Theater Wide.

Key Words: **THAAD, USN, OPNAV, NTW, PAPER**

110. **Initial Draft, USAF White Paper (Vision) on Theater Air Defense,** 7 August 1995.

Addresses the multifaceted threat and describes the Air Force Theater Air Defense (TAD) strategy and the military capabilities the Air Force is pursuing to counter them.

Key Words: **USAF, TAD, PAPER**

111. **Working At Top Speed To Bolster TMD**, LTG J. Garner, U. S. Army, Commander SSDC, The Army Greenbook, Department of the Army (October 1995).

Presents, from the view of the Army TMD Advocate, a description of the Army TMD capabilities.

Key Words: **TMD, USA, SSDC, PEO-MD, PAPER**

112. **Scud Alert! The History, Development and Military Significance of Ballistic Missiles on Tactical Operations,** Bryon E. Greenwald. No. 22 - The Institute of Land Warfare, AUSA, Arlington, VA, October 1995.

Traces the early history and recent development of ballistic missiles, concluding with an examination of the impact of ballistic missiles on tactical forces during all phases of force projection operations.

Key Words: **USA, BMD, TMD, FORCE PROJECTION, PAPER**

PLANS

113. **CMD, Advanced Concept Technology, Phase I (Mountain Top) ACTD Management Plan.** unsigned, August 1994.

Provides a top-level description of the first phase of the CMD ACTD and defines participant roles, required resources, background/status of component systems, and discusses particulars of the ACTD.

Key Words: CMD, ACTD, MOUNTAIN TOP, BMDO, USN, USA, PLAN

114. **Force 21 Annex F, Air Defense Artillery (U.S. Army 1996 Modernization Plan),** 22 December 1995.

Provides an overview of the mission requirements and objectives of the 21st century Air Defense Artillery force, a current program assessment, and the strategy for the modernization of the force.

Key Words: USA, PLAN, ARTILLERY, PEO-MD, TMD

115. **Force 21 Annex G, Missile Defense (U.S. Army 1996 Modernization Plan),** 22 December 1995.

Describes the Army's approach to missile defense for both NMD and TMD.

Key Words: USA, PLAN, MISSILE, PEO-MD, TMD, NMD, TBMD, BMD

REFERENCE MATERIAL

116. **GOING BALLISTIC -- The Build-Up Of Missiles In The Middle East**, Martin S. Navias, Brassey's (UK), Ltd., copyright 1993.

Provides information which throws some light on the complexities underpinning rationales and motivations which drive regional ballistic missile proliferation; seeks to show how states purchase and develop the weapons, the resulting military implications and the problems posed for defense and arms control; and presents some general estimates of regional missile forces and their capabilities.

Key Words: **TMD, TBMD, PROLIFERATION, ARMS CONTROL, USA, REFERENCE**

117. **1994/95 Guide to TMD**, J. W. Schomisch, Pasha Publications, copyright 1994.

A compendium of TBMD information from around the world covering TMD history, TMD relationship to the Anti-Ballistic Missile (ABM) Treaty, details of TMD programs, synopses of Allied and nations TMD efforts, and Third World missile and weapon proliferation.

Key Words: **TMD, TBMD, ABM, TREATY, USA, USN, USAF, USMC, REFERENCE**

118. **Department of Defense Directive 5134.9, subject: Ballistic Missile Defense Organization.** 14 June 1994.

The updated directive which established the BMDO as an agency of the Department of Defense with the responsibilities, functions, relationships, and authorities as prescribed in the document.

Key Words: **BMDO, CHARTER, OSD, USD (A&T), USA, USN, USAF, USMC, REFERENCE**

119. *Defense Planning Guidance: FY 1997-2002, William J. Perry, Secretary of Defense. 1995.

Presents the details necessary for the preparation of the budget submission for FY 1997-2002.

Key Words: **DPG, OSD, JCS, USA, USN, USAF, USMC, REFERENCE**

120. **A National Security Strategy Of Engagement And Enlargement**, Office of the President of the United States, preface by William J. Clinton, February 1995.

Explains the Clinton Administration's strategy of engagement and enlargement, and describes briefly how the Administration is applying this strategy to the world's major regions.

Key Words: **BMD, TMD, STRATEGY, OSD, JCS, REFERENCE**

121. ****BMDO Joint Forces Directorate TMD User Handbook**, March 1995.

Provides a quick executive overview on TMD topics for the theater CINCs and CINC staffs.

Key Words: **TMD, BMDO, HANDBOOK, REFERENCE**

REPORTS AND STUDIES

122. BALLISTIC MISSILE PROLIFERATION -- An Emerging Threat, System Planning Corporation. directed by Dr. Robert G. Nagler, copyright 1992.

Focuses on proliferation of ballistic missile with ranges of 300 km or greater in countries other than the U.S. and is intended to assist in reaching informed judgements on issues pertaining to potential responses to the threat of missile proliferation.

Key Words: **SRBM, MRBM, PROLIFERATION, MTCR, USA, USN, REPORT**

123. **The Story of Patriot in Desert Storm**, HQDA, DCSOPS/FDE and the Patriot Project Office, 28 September 1992.

Explains in an unclassified format how the U.S. Army used Patriot in Desert Storm to fight and win the first anti-missile combat in history. It looks at how the Patriot system works, the characteristics of the Iraqi-modified Scud, and what it takes to shoot a Scud with a Patriot.

Key Words: **TBMD, TMD, PATRIOT, USA, PEO-MD, REPORT**

124. **Report to Congress on the Theater Missile Defense Initiative (TMDI), 1993,** undated (circa June 1993).

Prepared by the Strategic Defense Initiative Office and submitted by the Secretary of Defense (SECDEF).

Key Words: **TMDI, CONGRESS, BMDO, OSD, REPORT, REFERENCE**

125. **Army Science Board (ASB) 1993 Summer Study Final Report on Missile Defense Programs,** December 1993.

Focused on the theater missile threat, the study looks at ways to strengthen Army TMD and TAD programs, to strengthen Army organization and capabilities, and ways to reduce program costs.

Key Words: **ASB, BMD, TMD, CMD, STUDY, REPORT**

126. **Joint Staff Report on Theater Air Defense, with Executive Summary (U),** December 1993.

Provides the results of the joint mission area analysis which comprehensively reviewed TAD requirements, capabilities, and deficiencies.

Key Words: **JCS, TAD, REPORT, STUDY**

127. **Third U.S. - Allied TMD Workshop, Summary Report,** May 1994.

Hosted and chaired by LTG Daniel Christman, USA, U.S. Representative to the NATO Military Committee, conducted 22-23 November 1993, the workshop emphasized individual service planning priorities and joint/combined force operational considerations. Special attention was given to prospects for sensor netting, data exchange and communications upgrades, and BMC3I advancements to facilitate joint/combined connectivity and interoperability.

Key Words: **WORKSHOP, REPORT, TMD, NATO, C2**

128. **Controlling the Spread of Land-Attack Cruise Missiles,** K. Scott McMahon and Dennis M. Gormley, foreword by Albert Wohlstetter. American Institute for Strategic Cooperation, January 1995.

Examines the effectiveness of export control regimes in constricting the spread of land-attack cruise missiles and their associated enabling technologies.

Key Words: **STUDY, REPORT, MTCR, CMD**

129. ****Defense Science Board (DSB) Summer Study Task Force on CMD, Study Report**, January 1995.

Provides an assessment of the current land-attack cruise missile threat, explores how this threat might evolve, evaluates the capabilities of existing systems against the emerging threat, and identifies options to improve these capabilities.

Key Words: CMD, DSB, OSD, REPORT, STUDY

130. ****Defense Planning Board/DSB Joint Task Force on TMD, Presentation of Interim Findings**, 20 March 1995.

Provides initial impressions, identifies some concerns based on their collective judgment, and a focus for the final effort and report.

Key Words: TMD, DSB, OSD, STUDY, REPORT

131. ***Army Active Defense TMD Strategy (U)**, 5 May 1995.

Develops the Army TBMD strategy for the 21st century in the context of the threat and mission requirements.

Key Words: USA, TMD, STRATEGY, STUDY

132. **Data Validation for the BMDO TMD COEA**, 4 April 1995.

Forwards the results of the HQ/USAF SAB assessment to the USAF Executive Agent for Theater Air Defense and provides recommendations for specific performance criteria where appropriate and suggests changes where appropriate.

Key Words: COEA, BMDO, TMD, USAF, EA-TA, STUDY, REPORT, MEMO

133. **Directions for Defense, Report of the Commission on Roles and Missions of the Armed Forces**, 24 May 1995.

Reports on a study effort directed to "review . . . the appropriateness . . . of the current allocations of roles. missions. and functions among the Armed Forces; evaluate and report on alternative allocations; and make recommendations for changes in the current definition and distribution of those roles. missions. and functions". and supported the central message that ". . . in the 21st century. every DoD element must focus on supporting the operations of the Unified Commanders in Chief (CINCs)."

Key Words: ROLES, MISSIONS, OSD, STUDY, REPORT

134. ***Joint Area CMD Study (U), 21 August 1995.**

Reports progress of the near-term constructive simulation effort for Area CMD, provides insights and conclusions, and provides an opportunity for course correction.

Key Words: **CMD, JCS, STUDY**

135. **Attack Operations Study, MIT Lincoln Laboratories, In-Progress Review Meeting, 8 September 1995.**

Provides a briefing status report on the study effort. The final results of the study are contained in the following classified report briefing.

Key Words: **ATTACK, MIT, STUDY, BRIEFING**

136. ***NATO Senior Defense Group on Proliferation, Active Defense Sub-Group, Final Report (U), 29 September 1995.**

Details the study effort, conclusions and recommendations of the group in its assessment of active defense capabilities needed by NATO to address the proliferation of weapons of mass destruction and their means of delivery.

Key Words: **NATO, PROLIFERATION, REPORT, STUDY**

137. **Report to Congress on BMD, 1995, September 1995.**

Prepared by the BMDO and submitted by the SECDEF.

Key Words: **BMD, CONGRESS, BMDO, OSD, REPORT, REFERENCE**

138. ***Attack Operations Study (A Quick-Reaction Study for OSD and BMDO) (U),** W. P. Delaney, M. Gruber, MIT Lincoln Laboratories, Lexington, MA, 5 October 1995.

Reports the final results of a study tasked to provide an engineering estimate of Attack Operations effectiveness given capabilities which are postulated to be available in the TMD COEA scenario timeframes. Additionally, the study was asked to postulate how much better Attack Operations effectiveness could reasonably be expected to improve, what capabilities would have to be advanced to achieve those improvements, and how far the capabilities would have to be advanced.

Key Words: **ATTACK, OSD, MIT, BRIEFING, STUDY**

139. ****TMD C2 Plan, BMDO, Coordination Draft,** 31 October 1995.

Provides a comprehensive, integrated description of BMC4I for active defense against TBMs including an operational concept, existing/planned architectures, proposals/programs for proving/implementing TMD BMC4I capabilities, specific issues, and recommendations for changes.

Key Words: **BMDO, C2, TMD, STUDY, REPORT**

140. ****TMD C2 Plan, BMDO, Attachments, Coordination Draft,** 31 October 1995.

Provides supplementary detailed data in amplification of the BMDO C2 Plan in the following categories: 1) TMD C2 Plan Study Plan, 2) Terms of Reference for Comprehensive TMD Missions and Program Analysis, 3) Integrated Architectures, 4) TMD BMC4I Interoperability Demonstration Tools and Facilities, 5) Work Breakdown Structure (WBS) Definitions, Descriptions, and Status, 6) WBS Flow Diagrams and Relationships, 7) WBS Assessment Tables, 8) Supporting Program Data, 9) TMD Program Schedules, 10) Task Durations, 11) Fiscal Year Recommendations.

Key Words: **BMDO, C2, TMD, STUDY, REPORT**

141. ****TMD C2 Plan, BMDO, Unclassified Annexes, Coordination Draft,** 31 October 1995.

Provides information in support of the BMDO C2 Plan in the following subject matter areas: B) Nuclear Environments, C) Joint Tactical Digital Information Link-J Communications Security Key Management, G) Cueing Advantages to TMD C2, H) TMD Correlation, I) Link-16 Decision and Implementation, J) CEC Support to TMD, M) GCCS, and N) International Interoperability.

Key Words: **BMDO, C2, TMD, STUDY, REPORT**

142. ***TMD C2 Plan (U), BMDO, Classified Annexes, Coordination Draft,** 31 October 1995.

Provides information in support of the BMDO C2 Plan in the following subject matter areas: A) Threat Scenarios, D) Combat Identification, E) Theater Event System Description, F) Shared Warning, K) Tactical Information Broadcast Service Support to TMD, and L) Tactical Related Applications Data Dissemination System Support to TMD.

Key Words: **BMDO, C2, STUDY, REPORT**

143. **Recommending a Development Path for the Navy Theater Wide BMD Program, Blue Ribbon Panel Study,** undated (circa October 1995).

Provides results of a study conducted for the U.S. Navy Program Executive Office for Theater Air Defense (PEO-TAD) and the BMDO.

Key Words: **NTW, USN, STUDY, REPORT**

144. ***Threat and Mission Priorities by JCS (J8), Draft Final Report (U),** undated (circa October 1995).

Contains the results of the analysis by the Joint Staff to determine threat and mission priorities, considering both theater ballistic and cruise missile defense.

Key Words: **JCS, THREAT, MISSION, REPORT, REFERENCE**

THREAT DOCUMENTS

145. ***TBMD Capstone System Threat Assessment Report, Draft (U),** 30 April 1995.

Provides, at the capstone level, a summary description of offensive and defensive suppression threats to the TBMD program.

Key Words: **STAR, TBMD, BMDO, DAB, OSD, THREAT, CAPSTONE**

146. ***Ballistic Missile Threat Summary (U),** 8 September 1995.

Briefing presented by Defense Intelligence Agency, provides an overview of potential ballistic missile threats to the continental United States and U.S. interests abroad, through 2015.

Key Words: **THREAT, DIA, BMDO, OSD, DAB, PUR**

TREATY DOCUMENTATION

147. **ABM Treaty and Related Documents,** treaty entered into force 3 October 1972, protocol entered into force 24 May 1976.

Provides the text of the treaty, the statements agreed upon and initialed by the Heads of the Delegations, the common understanding of the Parties reached during

negotiations, the noteworthy unilateral statements made by the U.S. Delegation during negotiation, and the Protocol to the Treaty.

Key Words: ABM, TREATY, PROTOCOL, CONGRESS

148. **Historical Overview of ABM Treaty Interpretation Debate,** D. J. Trachtenberg, TASC, 29 March 1993.

Provides a chronology of the debate from the point of view of a BMDO SETA support contractor.

Key Words: ABM, TREATY, PROTOCOL

149. **Traditional Interpretation of ABM Treaty Endorsed by Clinton Administration,** 14 July 1993.

Press release from the U.S. Arms Control and Disarmament Agency (ACDA) provides a statement for the congressional record stating the official position on the ABM treaty interpretation and a copy of the statement made by Thomas Graham, Jr., Acting Director, ACDA, to the Committee on Foreign Relations, United States Senate.

Key Words: ABM, TREATY, PROTOCOL, ACDA, CONGRESS

150. **BMDO 1995 Report to Congress, Chapter 6, Treaty Compliance,** September 1995.

Provides an overview of the process used for and the current status of BMDO ABM Treaty compliance actions.

Key Words: ABM, TREATY, BMDO, CONGRESS

151. **ABM Agreement With Russia Is Said To Expand U.S. Antimissile Defenses,** *Washington Post.* 29 November 1995.

Provides information on an *understanding* which will allow the U.S. and Russia to move their negotiations back into the Standing Consultative Commission in Geneva.

Key Words: ABM, TREATY, PROTOCOL

APPENDIX F: LIST OF ACRONYMS

A

A&T	Acquisition & Technology
AAW	Anti-Air Warfare
ABI	Airborne Interceptor
ABL	Airborne Laser
ABT	Air-Breathing Threat
ACAP	Advanced Capabilities
ACDA	Arms Control and Disarmament Agency
ACTD	Advanced Concept Technology Demonstration
ASCM	Anti-Ship Cruise Missile
ASN	Assistant Secretary of the Navy
AWACS	Airborne Warning and Control System

B

BE	Brilliant Eyes (Now Space and Missile Tracking System)
BMC3I	Battle Management, Command, Control, Communications, and Intelligence
BMC4I	Battle Management, Command, Control, Communications, Computers, and Intelligence
BMD	Ballistic Missile Defense
BMDO	Ballistic Missile Defense Organization
BPI	Boost-Phase Intercept/Interceptor
BUR	Bottom-Up Review

C

C2	Command and Control
C3	Command, Control, and Communications
C3I	Command, Control, Communications, and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
CARD	Cost Analysis Requirements Document
CEC	Cooperative Engagement Capability
CEP	Circular Error Probable
CINC	Commander-in-Chief (of a Unified Command)

H

HATMD	High Altitude Theater Missile Defense
HE	High Explosive

I

IOC	Initial Operational Capability
ISR	Intelligence, Surveillance, and Reconnaissance

J

JCS	Joint Chiefs of Staff
JFC	Joint Force Commander
JP	Joint Publication
JROC	Joint Requirements Oversight Committee
JROCM	Joint Requirements Oversight Committee Memorandum
JTAGS	Joint Tactical Ground Station
JTMD	Joint Theater Missile Defense

L

LACM	Land-Attack Cruise Missile

M

MEADS	Medium Extended Air Defense System
MNS	Mission Needs Statement
MOE	Measure of Effectiveness
MRBM	Medium-Range Ballistic Missile
MW	Missile Warfare

N

NAD	Navy Area Defense
NATO	North Atlantic Treaty Organization
NMD	National Missile Defense
NSWC/DD	Naval Surface Warfare Center, Dahlgren Division
NTW	Navy Theater Wide

O

OPNAV	Office of the Chief of Naval Operations
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OUSD	Office of the Under Secretary of Defense

P

P3I	Pre-Planned Product Improvement
PAC-3	Patriot Advanced Capability-3
PAC-4	Patriot Advanced Capability-4
PD-V	Project Definition-Validation
PEO	Program Executive Office
PEO-MD	Program Executive Officer, Missile Defense (Army)
PEO-TAD	Program Executive Officer. Theater Air Defense (Navy)
POM	Program Objectives Memorandum
PROGUS	Program Upgrade Study
PUR	Program Update Review

S

S&TS	Strategic and Tactical Systems
SAB	Scientific Advisory Board
SAC	Systems Analysis Contractor
SAM	Surface-to-Air Missile
SBIRS	Space-Based Infrared System
SECDEF	Secretary of Defense
SECNAV	Secretary of the Navy

SM	Standard Missile
SM-2	Standard Missile-2
SMTS	Space and Missile Tracking System
SRBM	Short-Range Ballistic Missile
SSC	Strategic Systems Committee
SSDC	Space and Strategic Defense Command (Army)

T

TAD	Theater Air Defense
TBM	Theater Ballistic Missile
TBMD	Theater Ballistic Missile Defense
TEL	Transporter Erector Launcher
THAAD	Theater High Altitude Area Defense
TM	Theater Missile
TMD	Theater Missile Defense

U

UAV	Unmanned Aerial Vehicle
UOES	User Operational Evaluation System
USAADASCH	United States Army Air Defense Artillery School
USAFSPACECOM	United States Air Force Space Command
USARSPACECOM	United States Army Space Command
USD	Under Secretary of Defense
USSPACECOM	United States Space Command

W

WMD	Weapon(s) of Mass Destruction